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Plastering and Architectural Terra Cotta

Prepared Under Supervision of

WILLIAM S. LOWNDES, Ph. B.

MEMBER, AMERICAN INSTITUTE OF ARCHITECTS
DIRECTOR, SCHOOL OF ARCHITECTURE AND BUILDING CONSTRUCTION
INTERNATIONAL CORRESPONDENCE SCHOOLS

PLASTERING

BY

D. KNICKERBACKER BOYD, F.A.I.A.

AND

WILLIAM S. LOWNDES, PH. B.

ARCHITECTURAL TERRA COTTA

CHARLES E. WHITE, JR., MEMBER, AMERICAN INSTITUTE OF ARCHITECTS

REVISED AND ENLARGED BY

CHARLES H. SIERKS, VICE-PRESIDENT, AMERICAN TERRA COTTA CORPORATION
CHICAGO, ILL.

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PLASTERING

Serial 2019-2 Edition 2

INTRODUCTION

1. Plastering is the process of applying a plastic material known as *plaster* to the surfaces of walls and ceilings so as to produce a neat, smooth, and satisfactory finish. This process is applicable to both the exterior and the interior of the structure. Plaster applied on the exterior of the building is called *stucco*. When applied on the interior of the building it is called *plastering* or *interior plastering*.

Plain plastering consists of covering surfaces with a plain coating of plaster of a uniform finish.

Ornamental plastering is the art of forming plaster ornament in relief upon plain surfaces. This relief is in the form of moldings, ornaments, pilasters, cornices, panels, and other architectural or decorative features which add beauty and dignity to the interior walls and ceilings.

PREPARATION OF THE BASE

SURFACES TO BE PLASTERED

2. Plaster is merely a coating and must be properly supported. It is, therefore, necessary that a suitable foundation, or *base*, be provided to which the plaster can be applied. Such a base exists in the rough surfaces of brick, stone, terra cotta, and other masonry walls. As a rule, however, a base is formed on these walls by means of furring and lathing, to which plaster is applied. In wooden buildings, the base consists of lathing that is applied directly to the frame work of the building.

3. Masonry Walls.—Walls of common brick offer a good surface to which plaster will adhere, especially when the bricks have rough surfaces, and the joints in the brickwork are not entirely filled with mortar. Hollow brick, hollow tile, and gypsum blocks are usually grooved so as to provide a good grip, or base, for the plaster. The surface of stone is not as good as that of brick, but if the stone is rough and the joints are more or less open the plaster will hold to the stonework in a satisfactory manner.

Plaster is generally applied directly to the outside of masonry walls. It is, however, rarely applied to the inside, since water is apt to work its way through a solid wall, and injure the interior plaster.

4. Condensation.—Another objection to plastering directly on the inner surface of a solid masonry wall is that in cold weather the wall becomes cold throughout, including the interior plaster work. When the warm air of the room comes in contact with the cold plaster surface, the moisture in the air is condensed on this surface. This moisture may prove to be very injurious to wall paper, painting, or other decorations that may have been applied to the plaster.

FURRING

5. Methods have been devised to keep condensed moisture from forming on walls, by constructing the walls with hollow spaces in their thickness, or using hollow terra-cotta tiles or hollow bricks. These devices, however, cannot always be depended upon. Consequently, it has become a general practice to fasten wooden or metal strips, known as *furring*, to the inside of masonry walls, to form an air space between the wall and the inside plastering. Furring serves three purposes. It prevents water from working its way through the inside plaster; it prevents condensation of moisture on the inner surfaces of the plaster; and it provides a space back of the lath in which the plaster can form a key.

6. Wooden Furring Strips.—Wooden furring strips, or furring, are shown at *a* in Fig. 1. These strips are usually 1 inch thick by 2 inches wide and are nailed to the wall

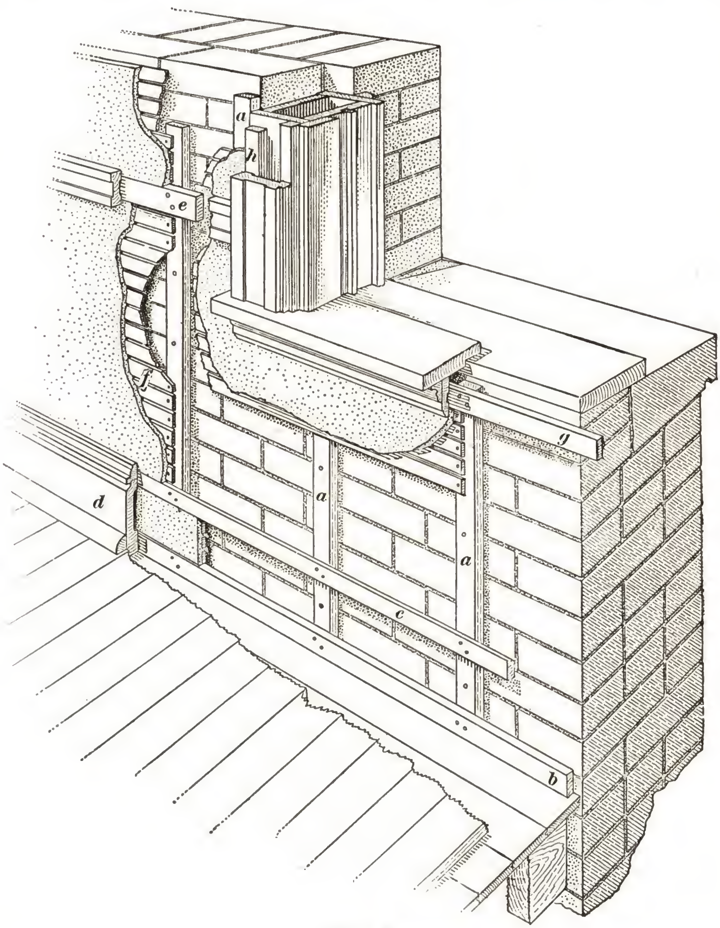


Fig. 1

vertically by a carpenter. These strips are placed either 12-inches or 16-inches on centers.

7. Metal Furring.—Metal furring consists of strips of metal which are attached to the surface of the wall, and to

which lath is applied. Metal furring may be of various standard structural forms, such as small-sized channels,

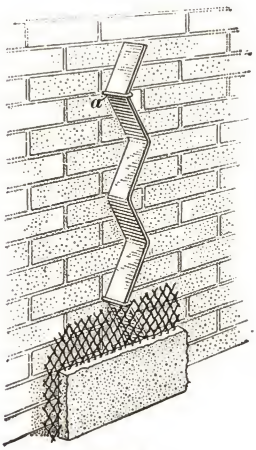


FIG. 2

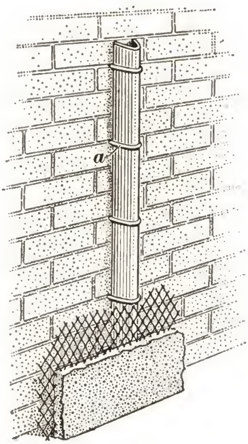


FIG. 3

angles, **I** beams, or **T**'s, or it may be of forms especially designed for the purpose. In Fig. 2 is shown a simple form of metal furring made by bending a flat strip of metal, which is attached to the wall by means of staples *a*. In Fig. 3 is shown a strip bent into a **U**-shape, secured to the wall by means of the staples *a*.

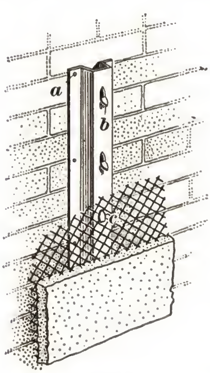


FIG. 4

In Fig. 4 is shown a sheet-steel furring strip which is nailed to the wall through the holes *a* on the sides. The furring holds the metal lath by means of the prongs *b*, which are bent over the lath to hold it in place, as at *c*.

8. Combined Furring and Lathing.—Metal lath, Fig. 5, with raised **V**-shaped portions, or ribs, is frequently used as the base for plaster on masonry walls. These ribs act as furring, and the separate furring strips are omitted because the sheet part of the lath is separated from the wall sufficiently to form an

air space after the plaster has been applied to the lath. The use of this form of lath and furring is seen in Fig. 6, the fur-

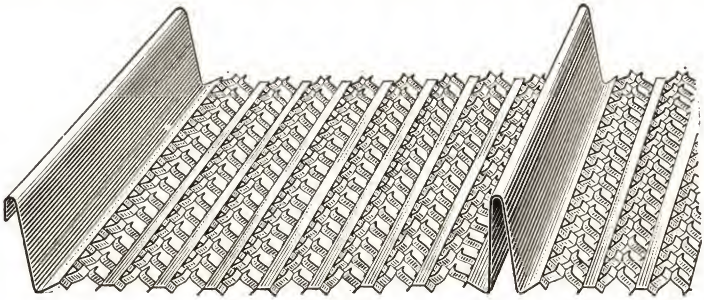


Fig. 5

rings or ribs *a*, being stapled to the brick walls, while the lath surface *b*, is held away from the wall. This form of lath may be applied directly to the exterior sheathing of frame buildings

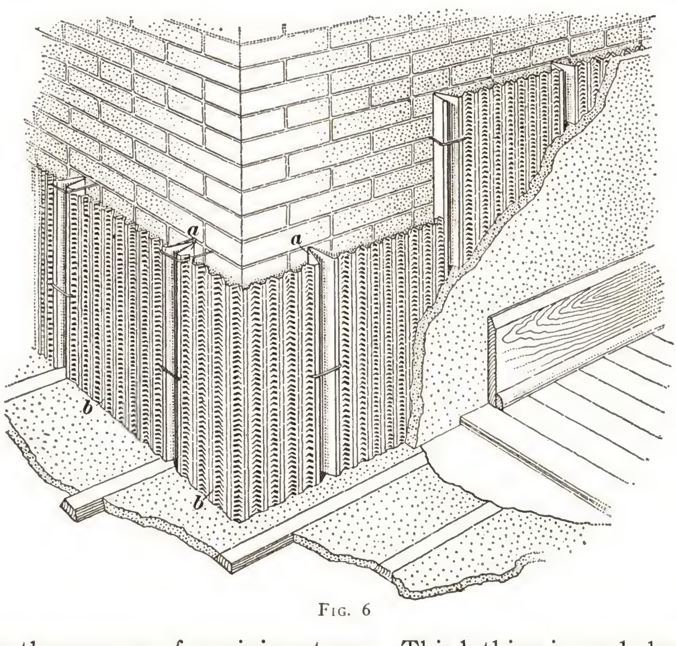


Fig. 6

for the purpose of receiving stucco. This lathing is used also as a support for solid plaster partitions as will be described later.

9. Cross-Furring.—Wooden furring strips *a*, Fig. 7, are sometimes nailed to the under sides of floor joists *b*, in order to make the ceiling level. This process is called *cross-furring*. The under surfaces of the floor joists are not always in the same plane, some being higher than others.

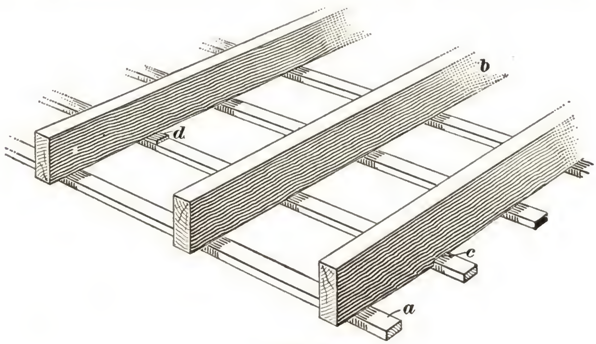


Fig. 7

When this occurs the furring is notched as at *c* when the joists are low, and is wedged down as at *d*, when the bottoms of the floor joists are high. The under surface of the cross-furring is thus made level and ready to receive the lathing and the plastering.

GROUNDS

10. *Grounds* are strips of wood which are applied to walls as guides in plastering and to furnish nailing for the interior trim. Grounds are illustrated in Fig. 1 at *b*, *c*, *e*, *g*, and *h*; also in Fig. 8 at *a*, *b*, *c*, *d*, *e*, and *f*. These grounds must be secured to the wall so that the finished plaster surface will be even with the surfaces of the grounds, and the finished surfaces of the plaster will be even, plumb, and true.

When plaster is applied directly to masonry walls, grounds are applied directly to the masonry. The interior surfaces of such walls are generally uneven and to take up this unevenness the plaster must be made thicker in some places than in others. Grounds applied to such walls must also be varied in thickness. In some places they must be made $\frac{1}{2}$ inch and in

other places an inch or more thick. These thicknesses must be adjusted so that the finished surfaces of the grounds on a wall will be in the same plane and the plaster surface will be even, plumb and true.

As a rule, masonry walls are furred and the grounds are applied on top of the furring as illustrated in Fig. 1. In such cases the thickness of the grounds is determined by the required thickness of the plaster coat, or, more exactly, the distance between the face of the furring and the face of the plaster.

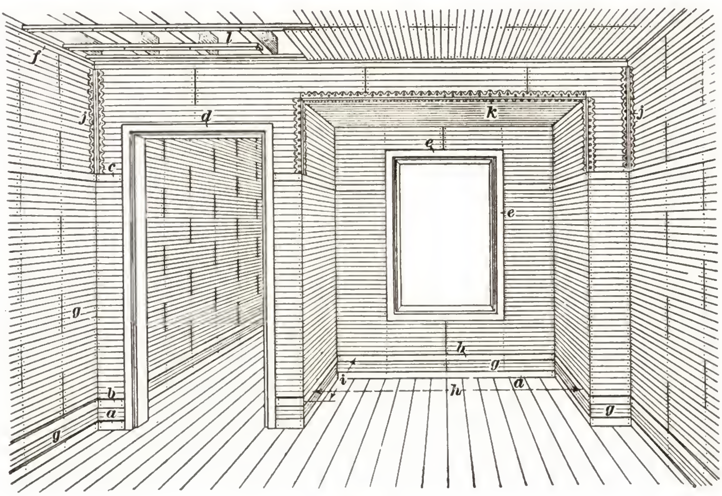


FIG. 8

This, in turn, depends upon the kind of lath used, the kind of plaster applied and the number of layers or coatings of plaster.

11. Thickness of Grounds.—The thickness of the plaster depends upon the nature of the base which supports the plaster or the surface to which the plaster is applied. Thus, for three coats of plaster, which are commonly used, the grounds should be of the following thicknesses: On gypsum block $\frac{1}{2}$ inch; on brick walls $\frac{1}{2}$ inch to $\frac{3}{4}$ inch; on clay tile $\frac{1}{2}$ to $\frac{3}{4}$ inch; on wood or metal lath $\frac{3}{4}$ inch; and on plaster board $\frac{3}{4}$ to $\frac{7}{8}$ inch.

When grounds are used in frame buildings, they are applied directly to the studding and are made from $\frac{5}{8}$ to $\frac{7}{8}$ inch thick.

12. Application of Grounds.—In Fig. 1 is shown a method of applying grounds to a furred wall. In Figs. 9 and 10 grounds are shown applied to stud walls or partitions. It will be seen that the grounds define the limits of the plaster as regards its thickness. At the same time, the grounds are placed so as to afford nailing for the trim.

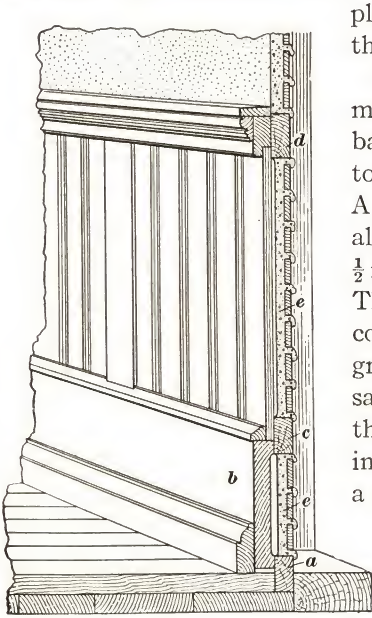


Fig. 9

In Fig. 1 is shown an arrangement of grounds to support a base board. A ground *b* is nailed to the furring *a* at the floor line. A second ground *c* is placed parallel to this strip so as to be about $\frac{1}{2}$ inch below the top of the base *d*. The mold on the base will then cover the joint between the ground *c* and plaster. At the same time, the base board and the top molding can be nailed into this ground. A ground for a chair rail is shown at *e* and is made narrower than the chair rail so that the chair rail will cover the joints between the plaster and the ground.

Grounds applied to hold a wainscot in place are shown at *a*, *c*, and *d* in Fig. 9. The grounds *a* and *c* provide nailing for the base *b*, the ground *c* holding the lower ends of the matched boarding, and the ground *d* holding the upper ends of the boarding as well as the cap of the wainscot.

At *a* in Fig. 10 is a ground for a picture molding and at *b* are grounds that support a wooden cornice. The plastering inside such a cornice need not have the finished coat as it will not be seen.

On stud walls, the lath and one or two coats of plaster should always be carried down to the floor, back of bases, and wainscots, and behind wooden cornices. This, as illustrated in Fig. 9 at *e*, forms a protection against fire and vermin and prevents contact of the wood with the plaster. In Fig. 8 at *g*, lath is shown back of a wainscot and base.

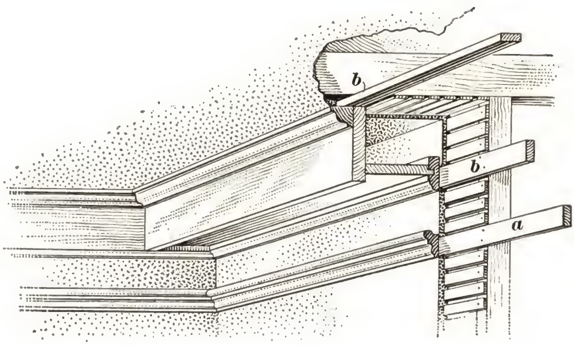


FIG. 10

13. Measuring to Grounds.—When wainscots, paneling, mantels, or other finished woodwork is to be installed in a room, measurements from which to execute such work can be taken as soon as the grounds are in place. The measurements between grounds will be the same as between plaster surfaces. Thus, in Fig. 8, measurements for paneling or wainscoting in the bay, such as at *h* or *i*, can be taken from the grounds. The wainscoting can then be manufactured or *gotten out* while the plastering is being applied.

CORNER BEADS

14. Metal Corner Beads.—When plastered corners are not chamfered or rounded, the angles of plastered walls and piers should be protected by metal *corner beads*, as shown in Figs. 11 to 17 inclusive. These beads furnish grounds for the plaster to finish against, as at *j* and *k* in Fig. 8, and form corners that will not be easily injured.

One form of metal corner bead, applied to a wood lath base, is shown at *a* in Fig. 11. The sides *b* of the bead are

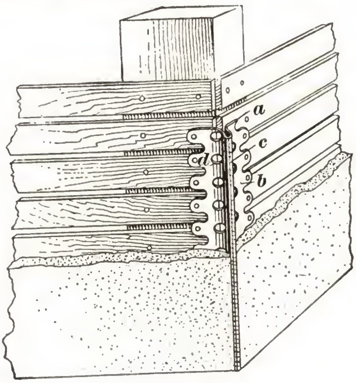


FIG. 11

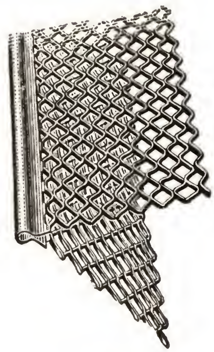


FIG. 12

bent to fit over the corner, and are punched with holes to receive nails by which the bead is attached to its support. The edge *c* of the bead is formed into a shape that will be rigid and will retain a straight edge during the process of plastering, thus forming a true, straight corner. Openings *d* in the sides of the bead permit the plaster to form a key, which prevents the plaster from breaking away from the metal. Another type is shown in Fig. 12, in which the wings are expanded to a form that is securely held by the plaster.

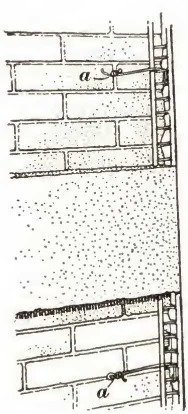


FIG. 13

In Fig. 13 is shown a bead attached to a brick corner, when the plaster is applied directly to the brick. The bead is held in place by wires secured to nails *a* driven firmly into the joints of the brickwork.

The bead shown in Fig. 14 is attached by wires *a* to a construction of metal furring and lath. The holes *b* may be used for nailing when this style of bead is used on a corner of wooden construction.

15. Bull-Nose Corner Beads.—For exposed corners in public buildings, hospitals, and other places subject to hard

knocks, a *bull-nose corner bead*, Fig. 15, is often used. By presenting a rounded metal corner, a bead of this style prevents injury to plaster from shocks or blows which might damage the ordinary metal bead.

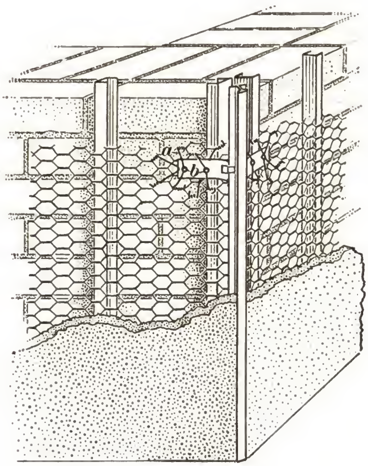


FIG. 14

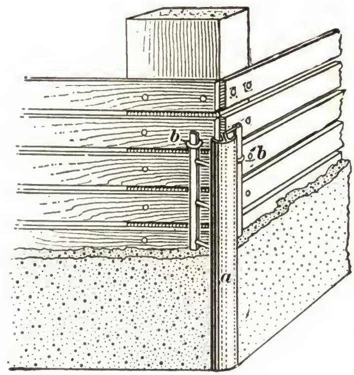


FIG. 15

The nose *a* is usually about $\frac{7}{8}$ inch wide and is curved to a radius of about $\frac{9}{16}$ inch. Bull-nose beads are made in a number of styles which are attached to a wood base by means of staples *b*, or by wires to metal lath.

Metal corner beads for inside angles, as in Figs. 16 and 17, are designed to form a ground against which the plaster may finish, and also to prevent cracks which sometimes occur at inside angles between walls, or between walls and ceilings. Holes *a* in the sides of the bead shown in Fig. 16 permit nailing to wood construction, or wiring to metal lath. The mesh of the sides of the bead shown in Fig. 17 permits fastening by means of wire. Frequently, however, 12-inch strips of metal lath are used in interior angles for reinforcement, as at *a* in Fig. 18, in which case inside beads are not needed. This

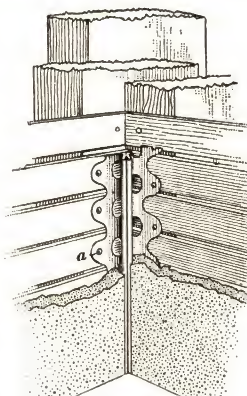


FIG. 16

treatment resists the tendency to crack which occurs at these corners.

Most of the styles of metal corner beads are made in 5-, 6-, 7-, 8-, 9-, and 10-foot lengths. The beads should be set carefully to plumb and straight lines, corresponding to the grounds, and be secured to the supports before the plaster is applied. They should extend in one piece for the whole length of the corner, unless the height is greater than the length in which the bead is made.

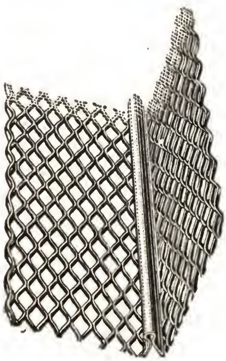


Fig. 17

16. Metal Base Screeds.—*Metal base screeds*, shown in Figs. 19 and 20, are sheet metal shapes used in place of wood grounds, at such places as between cement bases and plastered walls. They make neat joints at the union of the two materials, and assist in bringing each surface to true lines and levels. When the thickness of the cement base is greater than the thickness of the plaster, the cement is brought to the line of the edge *a* in Fig. 19, while

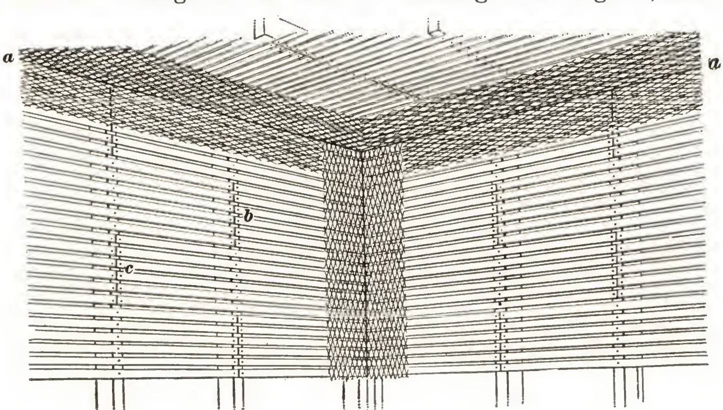


Fig. 18

the plaster is brought to the line *b*. Metal base screeds of the style shown in Fig. 20 are used when the cement base is the

same thickness as the plastering, both surfaces being brought out to the edge of the bead. Metal base screeds of the styles shown in Fig. 19 are attached to wood by means of nails through the holes *c*. On metal lath, wires through these holes will hold the screed

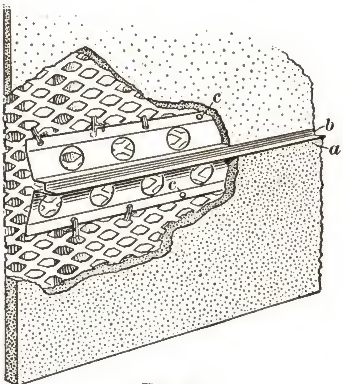


Fig. 19

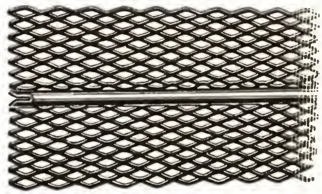


Fig. 20

in place, as shown in the figure. In the style shown in Fig. 20, the screed may be attached through the mesh of the sides.

LATH

17. *Lath*, or *Lathing*, is a base which is fastened to walls or ceilings, and is designed to provide a grip, or bond, to which the plaster will hold firmly. Lathing is made of wood or metal strips in various forms, or of composition boards.

WOODEN LATH

18. Common Lath.—Common wooden lath is made of white pine, fir, spruce, red cedar, hemlock, and yellow pine. The wood is sawed into strips $1\frac{1}{2}$ in. $\times \frac{3}{8}$ in. $\times 32$ in. or 48 in. The 32-inch length is designed for application to furring strips, joists, and studs that are set to the standard spacing of 16 inches on centers. The 48-inch lath, which is the more commonly used, may be used with 12-inch spacing, as well as with 16-inch spacing. Lath 1 inch wide and $\frac{1}{2}$ inch thick are recommended by some manufacturers as a base for stucco.

Lath $\frac{1}{4}$ inch thick is also made, but this thickness should not be used in the best grade of work.

All lath should be straight-grained to prevent their warping, due to the absorption of moisture from the plaster. They should be free from rot or decay to insure durability, clear of shakes, large or loose knots that will reduce their strength, and free from bark and resin pockets which may cause subsequent discoloration of the plaster.

Lath which are half-green, or only partially seasoned, are considered best for gypsum and cement plasters. Those used with lime plaster should preferably be well seasoned.

Common lath are sold by the thousand, one thousand lath 48 inches long being estimated to cover from 60 to 75 square yards of surface, depending upon the width of the spaces between the lath, and the number and size of the openings in the walls.

19. Application.—Common lath are nailed to the supports in parallel rows, as shown in Fig. 8, spaces being left between the sides and ends of the lath through which the plaster may be pressed to form a key which will hold the plaster firmly in place. When lime plaster is used, the lath applied to the ceiling joists should be spaced $\frac{3}{8}$ inch apart, and on the side walls, the lath should be spaced $\frac{1}{4}$ inch apart. For gypsum plaster, many of the manufacturers recommend spacing the lath not over $\frac{3}{8}$ inch apart, especially on ceilings, while some suggest that the lath should not be over $\frac{3}{16}$ inch apart on side walls. Care must be taken to space the lath evenly, in order that the keys may be equal in size and strength.

The ends of the lath should not lap over one another, but should be placed end to end and about $\frac{1}{4}$ inch apart. Continuous joints between the ends of the lath should not occur on one support, but the lathed surface should be divided into panels about 15 to 18 inches in height, as shown at *b* in Fig. 18 The vertical joints of these panels should break on alternate supports, as at *b* and *c*, or else continuous cracks in the plaster will be liable to form in front of these joints. Lath are

usually attached to joists and studs with cut or wire nails about $1\frac{1}{8}$ inches long, which have large flat heads, and one nail is used at each support.

20. Lath on Wide Surfaces.—Where joists, studs, or girders are over 2 inches in width, strips of lath, as shown at *a* in Fig. 21, should be attached to the surfaces to allow space for the plaster to form a key. Cross-furring may be applied to

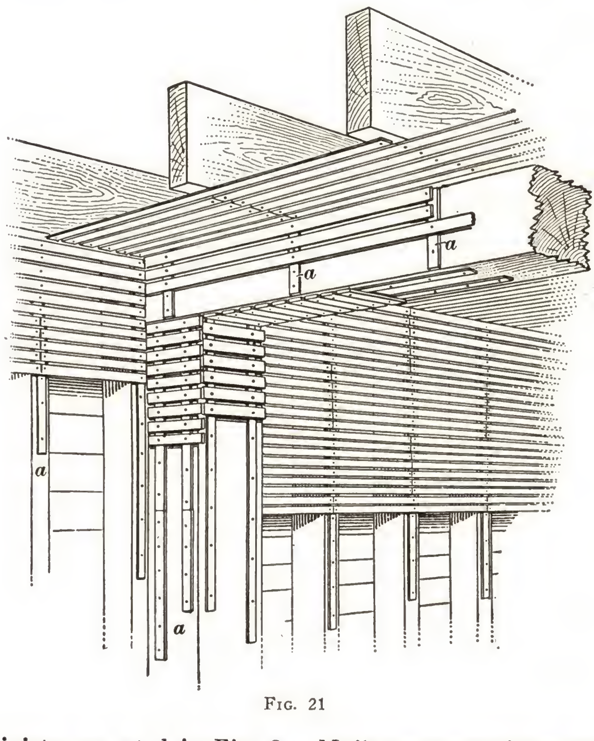


Fig. 21

thick joists, as at *l* in Fig. 8. Nails are sometimes studded thickly over wide surfaces of wood, such as beams, in order that the plaster may form a clinch around the heads of the nails. This is done instead of stripping.

21. Lathing for Back-Plastering.—The outside walls of frame houses are sometimes *back plastered* to help keep out the cold. *Back-plastering* consists of installing a lath base

between the studs, and coating this base with plaster. This form of construction is shown in Fig. 22. The vertical furring strips *a* are attached to the studding *b*, and the lath *c* are attached to these strips. The lath are separated from the outside boarding, or sheathing *d*, by means of these strips *a*, and a suitable space is provided in which the plaster may form a key, as shown at *e*. The air space between the sheathing *d* and the back-plastering acts as insulation to prevent the passage of heat and cold.

22. Sheathing Lath.—A combined sheathing and lath, known as *Byrkit lath*, is shown at *f* in Fig. 22. This lath consists of boards $\frac{3}{4}$ inch in thickness, containing grooves *h*, and is made in widths of $3\frac{1}{2}$ and $5\frac{1}{4}$ inches. The lath is made in lengths of 4 feet and upwards. Plaster is bonded to Byrkit lath by filling the dovetail-shaped grooves *h*. The back of the lath is also grooved, as shown at *i*, to prevent the lath from warping and splitting. The end joints of this lath are made on the support, as at *g*.

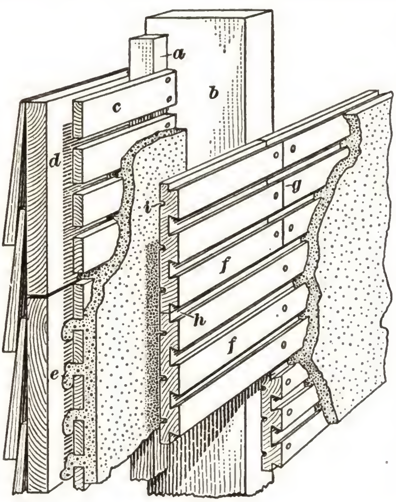


FIG. 22

The use of this form of lath adds great stiffness to the frame of the building, especially when long lengths are used. Sheathing may be omitted when this lath is used. Thin partitions may be made by using this lath on both sides of 2-inch studs. The lath is also useful for plastering sliding-door partitions, since no lining of the pockets is required. Nails can be driven anywhere in the lath without loosening the plaster.

23. Assembled Wooden Lath.—A form of lath known as *Bishopric Board* is shown in Fig. 23. This lath consists

of a waterproof fiber board *a* covered on one side with a waterproof coating *b* known as *asphalt mastic*. Creosoted wooden lath having beveled edges, as shown at *c*, are applied and the whole subjected to pressure, which causes the lath to adhere firmly to the board *a*. The asphalt coating makes the board both water- and air-tight. The dovetail spaces between the laths provide excellent keys for the plaster. Bishopric board is shipped in rolls, each roll containing one sheet 4 feet wide and 25 feet long.

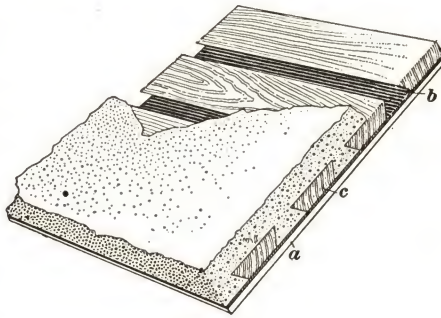


Fig. 23

METAL LATH

24. Forms of Metal Lath.—Steel and iron sheets and wire are worked into forms that may be used as bases for plastering. When made from sheets, the product is known either as *expanded-metal-lath*, as shown in Fig. 24, or as *sheet-metal lath*, as shown in Fig. 25. When made of wire, the product is called *wire lath*, or *metal fabric*, and is shown in Fig. 26.

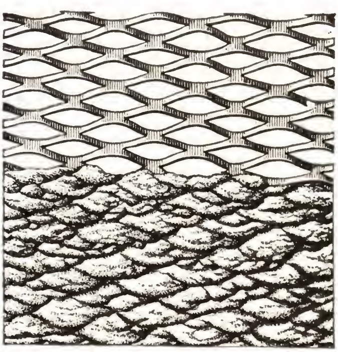
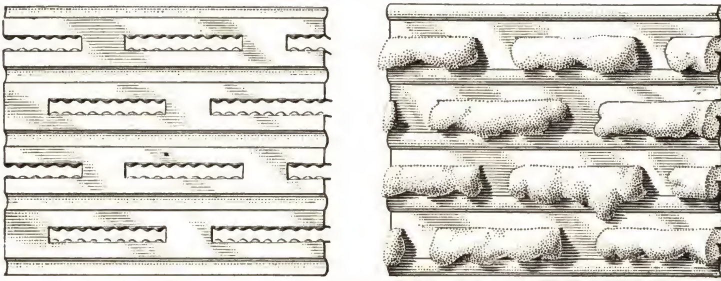


Fig. 24

25. In Fig. 24 is shown the back of a panel of expanded-metal lath, showing the key after plaster has been applied to the lath. In Fig. 26 is shown a panel of wire lath similarly treated. In Fig. 25 (*a*) is shown a panel of sheet-metal lath, and in (*b*) the reverse side of the same lath after plaster has been applied to it.

26. Protecting Metal Lath.—Steel is subject to corrosion on exposure to moisture. No metal lath, manufactured from steel, is now sold unless protected by a preservative paint covering, or by being galvanized. When steel is fully embed-



(a) FIG. 25 (b)

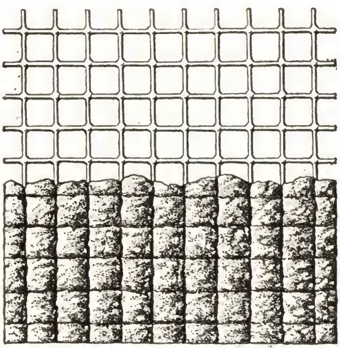
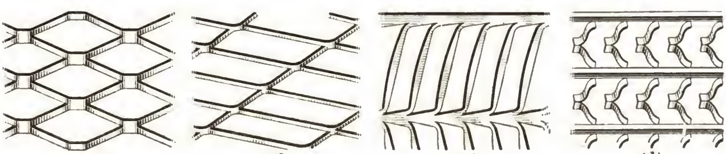


FIG. 26

ded in suitable plaster there is little danger of corrosion. In damp situations Portland cement plaster should be used, and it should fully embed the lath. Metal lath is also made of rust-resisting metal such as pure iron or copper-bearing steel

EXPANDED-METAL LATH

27. Expanded - metal lath derives its name from the process of manufacture. Sheets of metal are first slit and then expanded so that a mesh is



(a) (b) (c) (d)

FIG. 27

formed, through which the plaster may pass and form a key. Expanded metal is made in sheets from 16 to 24 inches wide, and usually 96 inches long.

28. Plain expanded-metal lath is shown in Fig. 27. As in (*a*) it is called the *diamond mesh;* in (*b*), the *oblong mesh;* in (*c*), the *herringbone lath,* and in (*d*), the *hy-rib lath.* There are many styles of expanded-metal lath, made in several weights of metal. The following is a portion of the General Specifications for Metal Lath Construction adopted by the Associated Metal Lath Manufacturers.

General.—Whenever metal lath construction is required the weights per square yard of metal lath and weights of supporting member and methods of attachment of metal lath thereto shall be specified not less than the following:

MINIMUM WEIGHT OF METAL LATH

(*a*) **Expanded Metal Lath for Interior Work**—

For vertical position, partitions, etc. attached to metal supports:

For 12, and 13½ in. on center, lath shall weigh a minimum of 2.5, and 3.0 lb., respectively, except for solid partitions where 2.2 lath may be used on 12-in. spacings; and 3.4 lath on 16-in. spacing. *For nailed-on partitions,* maximum spacing shall be 16 in. for all flat laths, minimum weigh to be .... 2.5 lb.

For tied-on ceilings attached to metal supports:

For maximum spacing shall be 12 and 13½ in. for 3.0 and 3.4-lb. flat lath; *for nailed-on ceilings* maximum spacing shall be 16 in. for these laths.

(*b*) **Flat Rib Lath**—

For nailed or tied-on partitions and furring:

For supports spaced not to exceed 16 in. on centers........... 2.75 lb.
For supports spaced not to exceed 19 in. on centers........... 3.0 lb.

For nailed or tied-on ceilings:

For supports spaced not to exceed 12 in. on centers........... 2.75 lb.*
For supports spaced not to exceed 16 in. on centers........... 3.0 lb.
For supports spaced not to exceed 19 in. on centers........... 3.4 lb.

(*c*) **⅜-in. Rib Lath**—

For nailed or tied-on partitions and furring:

For supports spaced not to exceed 19 in. on centers.......... 2.5 lb.
For supports spaced not to exceed 24 in. on centers.......... 2.75 lb.
For supports spaced not to exceed 31½ in. on centers.......... 3.4 lb.

For nailed or tied-on ceilings:

For supports spaced not to exceed 19 in. on centers.......... 2.75 lb.
For supports spaced not to exceed 24 in. on centers.......... 3.0 lb.
For supports spaced not to exceed 31½ in. on centers.......... 3.4 lb.†

(*d*) **Sheet Lath**—

For nailed or tied-on partitions maximum spacing 24 in........ 4.5 lb.
For tied-on ceilings not to exceed 19 in. on centers............ 4.5 lb.
For nailed-on ceilings not to exceed 24-in. on centers.......... 4.5 lb.

(*e*) **For Stucco Exteriors**—

Minimum weight of flat or self-furring expanded-metal lath attached to wood, metal or masonry, etc.................. 3.4 lb.
Minimum weight of expanded metal reinforcing used as in foregoing (with minimum opening of 1½ in.).................. 1.8 lb.

---

*For nailed-on ceilings this lath may be used 16 in. on centers.

†For wood joists maximum spacing any nailed-on rib lath 23⅞ in. Maximum of 33½ in. permitted for concrete joists.

Any style of metal lath may be used providing it meets the requirements as to weight per square yard.

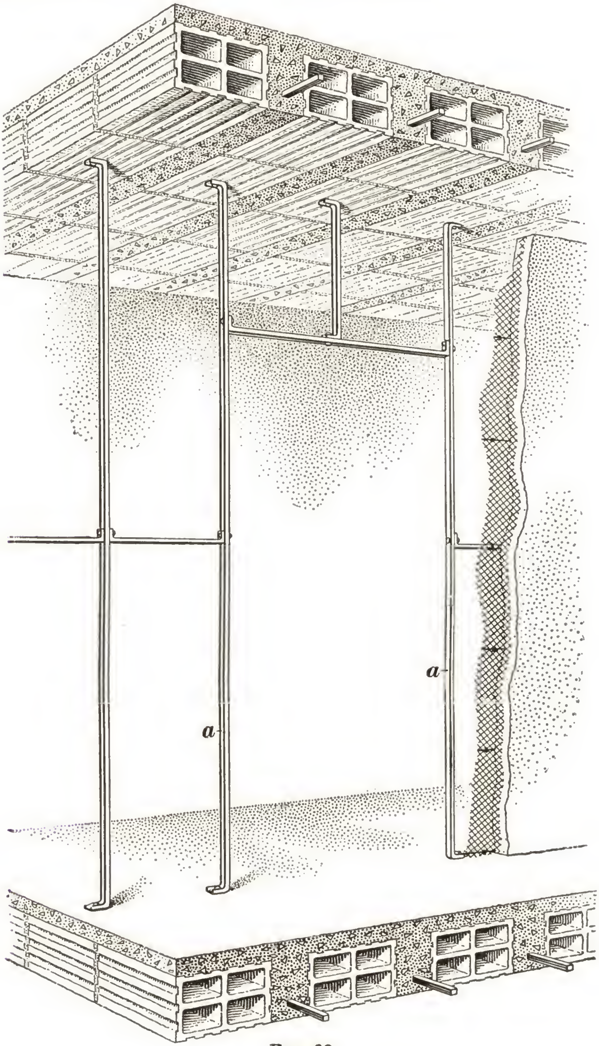


Fig. 28

29. Application of Plain Expanded-Metal Lath. Studding for the support of plain expanded-metal lath may

be of wood, of rolled structural shapes, such as channels or angles, as shown at *a* in Fig. 28, or of sheet-metal shapes, as at *a* and *b* in Fig. 29. The lath is attached to wood supports by $1\frac{1}{4}$ inch galvanized staples which are driven through the meshes of the lath at about 6-inch intervals at every support.

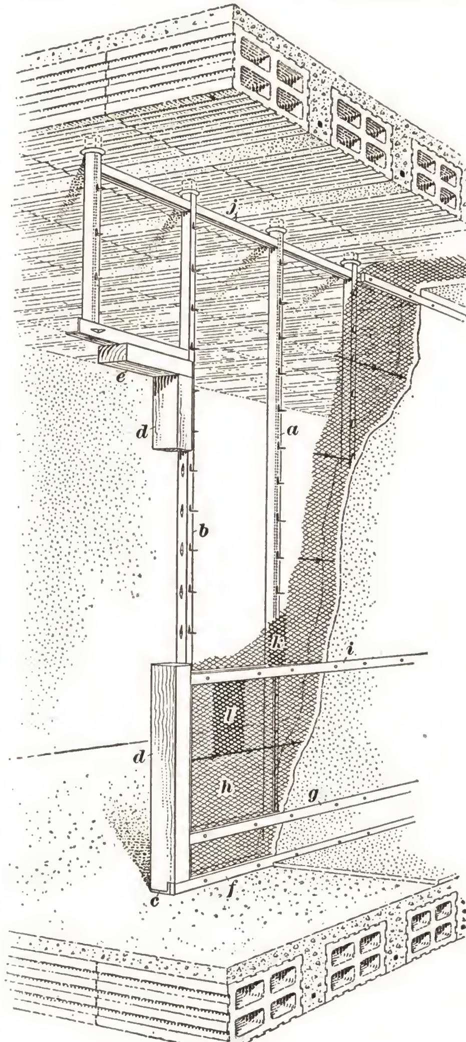


FIG. 29

When applied to metal supports, the lath is wired to the supports or fastened with clips. Three styles of clips are shown in Figs. 30, 31, and 32. The prongs *a* in Figs. 30 and 31 are intended to fit over the flange of an **I** beam, while the prongs *b* extend through the lath and are bent so as to hold the lath securely. The prongs *a* and *b* in Fig. 32 may all extend through the lath and be bent around the support, or two of the prongs, as the prongs *a* may be used to go around the support, while the other two may be bent back to go through the lath and hold it in place.

The sheets of lath are placed horizontally on the studding, the horizontal edges being lapped 1 inch or less. The edges are tied together with wire

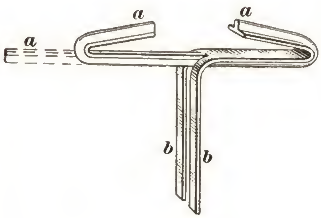


Fig. 30

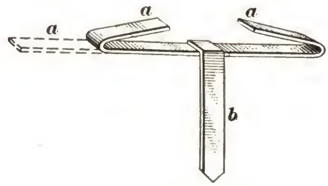


Fig. 31

and the lath is fastened to every stud. Where the ends of the sheets meet over a stud, as at *k* in Fig. 29, they are lapped about 2 inches and wired together and to the studs. Where the ends meet between the studs, as at *l*, they are lapped 8 inches and wired together.

Fig. 32

SHEET-METAL LATH

30. Metal lath, made of steel sheets which are punched out, or expanded in some parts in order to form a good key for the plaster, is classed as *sheet-metal lath*. The lath is made in plain flat sheets for ordinary lathing.

31. Forms of Sheet-Metal Lath.—A form of plain perforated sheet-metal lath is shown in Fig. 33. This lath, known as the *Sykes lath*, has ridges *a* about 2 inches apart. Portions *b* are punched out to form openings and loops *c*. Another form of sheet-metal lath is shown in Fig. 25. The *Bostwick*, or *Truss-Loop* lath has truss-like loops.

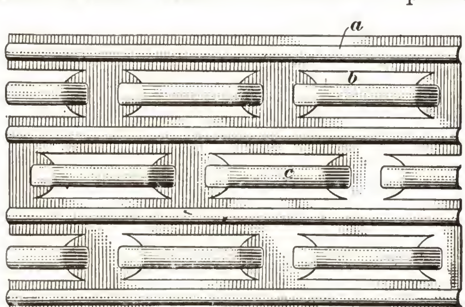


Fig. 33

32. Characteristics of Sheet-Metal Lath.—Sheet-metal lath is very rigid, and forms a stiff base on which to apply plaster. The openings in the sheet being smaller in proportion to the solid surface, less plaster is forced through the lath than with either wire or expanded-metal lath. The back cannot be covered with plaster and is therefore exposed to corrosion.

33. Application of Sheet-Metal Lath.—In general, the application of sheet-metal lath is similar to that for expanded-metal lath, except that nails are generally used in place of staples. The lath may be attached to wood supports, such as furring, joists, or studs, or to metal supports.

WIRE LATH

34. Plain Wire Lath.—Plain wire lath, sometimes called *metal fabric*, consists of wires that are woven together to form square or rectangular meshes. The wires are usually spaced $\frac{4}{10}$ inch on centers, leaving spaces about $\frac{3}{8}$ inch square, and producing what is technically termed *two-and-one-half mesh to the inch* (five wires to 2 inches). The wire is No. 20 gauge, the diameter of the finished material being .035 inch. Another spacing is two mesh to the inch ($\frac{1}{2}$ inch on centers), the lath being made of No. 18 gauge wire, which is .047 inch in diameter.

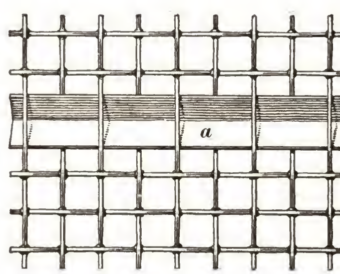


FIG. 34

35. Stiffened Wire Lath. Wire lath is better when stiffened so that it will not yield when the plaster is applied. Stiffeners are therefore woven into the lath at intervals of $7\frac{1}{2}$ to 8 inches. These stiffeners are in the form of round rods, or of **V**-shaped strips as illustrated at *a* in Figs. 34 and 35. This stiffening is part of the lath and does not take the place of furring.

In Fig. 34 is shown a panel of **V**-stiffened lath before the plaster has been applied, and in Fig. 35 is shown a back view

after the plaster has been applied. The metal is entirely embedded in the plaster, and is thus protected from rusting.

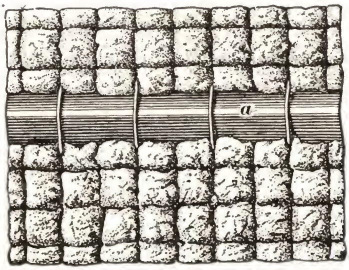


FIG. 35

Wire lath, both the plain and the stiffened, is furnished usually in rolls 150 feet in length, the stock width of the lath being 36 inches. When plain lath is to be used, the supports to which it is applied should be spaced not over 12 inches on centers, while if the stiffened lath is used the supports may be 16 inches on centers.

36. Application of Wire Lath.—In applying plain wire lath to wooden supports, $\frac{3}{4}$-inch round-top staples, as shown in (*a*), Fig. 36, are used generally, and fastenings are made at 6-inch intervals. The stiffened lath should be secured at each stiffener by means of $1\frac{1}{4}$-inch staples of the form shown in *b*. These staples will span the stiffeners. Lath that is applied to metal supports should be tied with No. 18 gauge galvanized annealed wire, plain lath being secured at 6-inch intervals, and stiffened lath secured at each stiffener. The lath should be lapped about 6 inches around corners and angles to minimize the cracking of plaster at such places.

37. Characteristics of Metal Lath in General. Metal lath is extensively used in fireproofing, and is valuable also in wood frame construction from the fact that plaster applied to metal lath is not liable to be injured by the usual shrinkage of the framing timbers. Plaster becomes firmly attached to all forms of metal lath, and ordinary accidents will not cause it to break away or become loosened. Metal lath is peculiarly adaptable to suspended ceilings, lending itself readily to bending into shapes to conform to the various moldings, panelings, etc., of an ornamental ceiling.

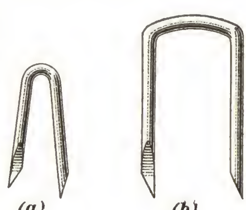
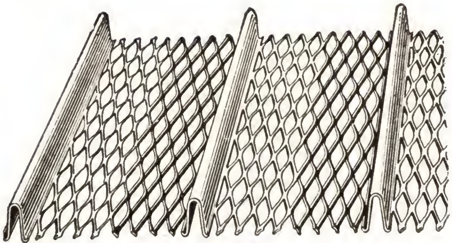


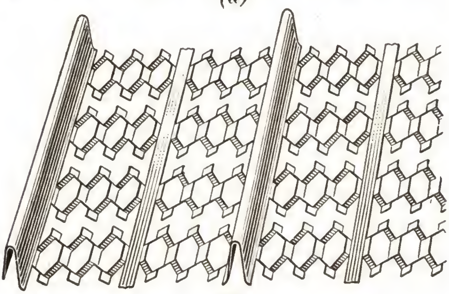
FIG. 36

In frame construction, metal lath gives to the plastered wall and ceiling two vital qualities, namely: permanence, or resistance to cracks, and resistance to fire. There are certain portions of buildings, notably dwellings, that are more vulnerable than others, and metal lath can be used in these places or parts at very little extra expense. Thus, metal lath may be used to prevent cracks in the plaster on the ceilings of prominent rooms, and it may be bent around and lapped 6 inches on either side of wall and partition angles, and around door bucks. It may be placed back of wainscots and tile mantels, across ducts for plumbing and heating plants, or as a foundation for stucco.

For use as fire-stops, or to prevent the spread of fire, metal lath may be used on all bearing partitions, and on all exterior walls. The bases of such partitions and walls may have metal-lath baskets for holding incombustible materials. Metal lath may be used for ceilings under much used rooms, and especially when the ceilings are over heating plants and coal bins. At chimney breasts and flues, and back of kitchen ranges, metal lath tends to prevent fire or heat from reaching the woodwork. Stair walls and soffits may be covered with metal lath. The use of metal lath for exterior walls will aid in preventing fire from reaching the woodwork of the building from the outside.

Wire lath and expanded-metal lath, as will be seen by reference to Figs. 24, 25, and 26, require more plaster than wooden lath or sheet-metal lath. This, however, is an advantage, for the plaster, which is a fireproofing material, nearly or completely encloses the lath, protecting it both on the face and on the back from exposure to fire and moisture. Metal lath entirely embedded in plaster will protect woodwork from fire for a considerable time. For this reason it should be placed back of ranges and stoves and their pipes, and should be separated by metal furring at least $\frac{3}{4}$ inch from the woodwork it is to protect. The Underwriters Laboratories, representing the fire insurance companies of the United States, consider that metal lath and plaster will protect woodwork from fire for a period of at least one hour.


(a)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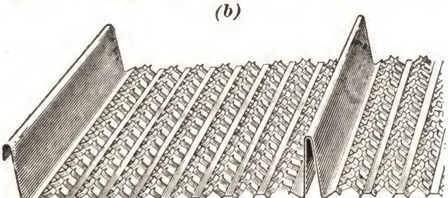
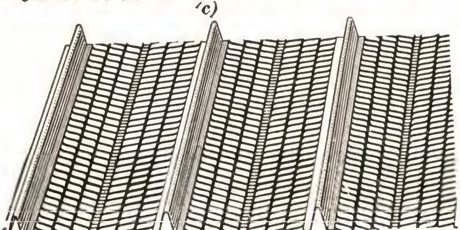
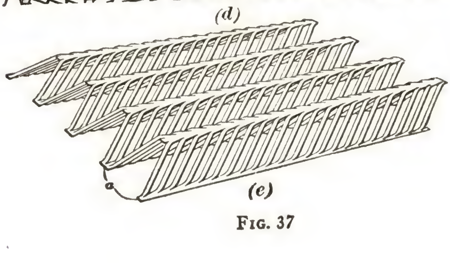

(c)


(d)



(e)

Fig. 37

REINFORCED OR RIBBED METAL LATH

38. Most of the forms of metal lath already shown are also manufactured with ribs or projections which are designed to act as furring or even as studs. This material, while here classified as metal lath, is better described as combination furring and lath and combination studding and lathing.

39. Reinforced Expanded Metal. In Fig. 37 are shown several examples of expanded metal having ribs of various designs. When the ribs are small, as in (*a*) and (*b*), they act as furring strips. The use of this material as combination furring and lath is illustrated in Fig. 6. Its use as combination lathing and studding is shown in Fig. 38. In this case the metal is entirely embedded in the plaster, which is 2 or more inches thick.

The styles of reinforced expanded-metal lath shown in (*a*), (*b*), (*c*), and (*d*) in Fig. 37 have **V**-shaped ribs from $\frac{3}{4}$ inch to $1\frac{1}{2}$ inches in height. The ribs are spaced from 4 to 8 inches apart depending on the style and height of rib.

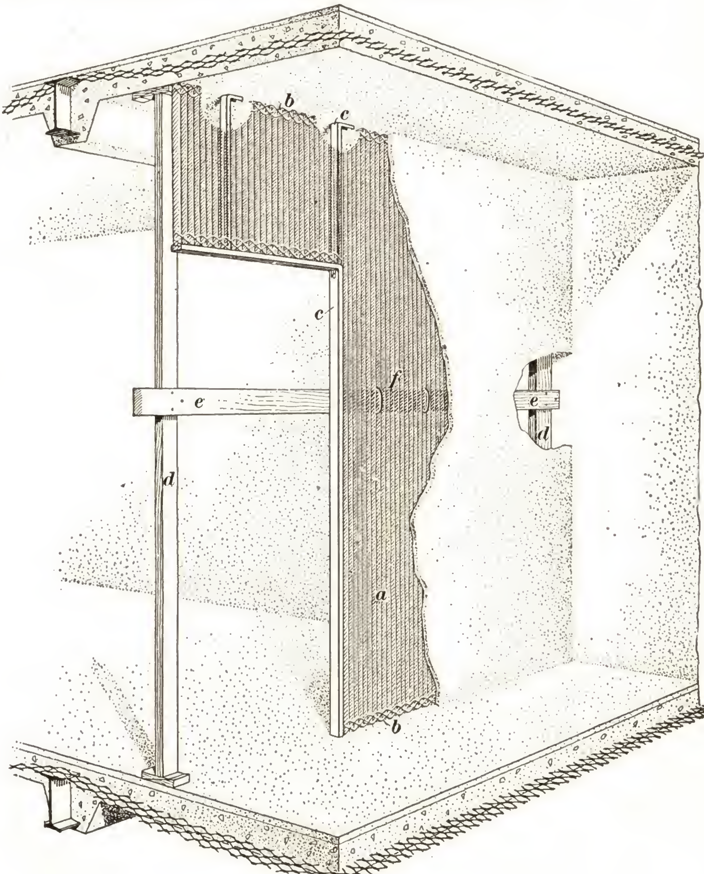


Fig. 38

Trussit (*e*) is a herringbone lath bent so as to be quite stiff. It is adapted to forming partitions and is embedded in solid plaster from 2 to $3\frac{1}{2}$ inches thick.

Fig. 38 illustrates the application of trussit to a solid partition. The trussit, *a*, is fastened to the floor and ceiling by the

metal forms *b*. Metal studding *c* must be used around door or other openings. Temporary bracing *d* and *e* is wired to the lath as at *f* to hold the partition until the plaster is in place.

The forms of reinforced lath shown in (*a*), (*b*), (*c*), and (*d*), Fig. 37, are used as furring and lathing. The ribs are usually spaced from 4 to 8 inches apart and are from $\frac{5}{16}$ to $1\frac{1}{2}$ inches high.

40. Reinforced or Ribbed Sheet-Metal Lath.—Most forms of sheet-metal lath are also made with deep ribs, usually spaced 4 or 8 inches on centers, similar in character and purpose to those described for expanded-metal lath. These ribs take the place of furring on masonry walls. One form of ribbed sheet-metal lath is shown in Fig. 39.

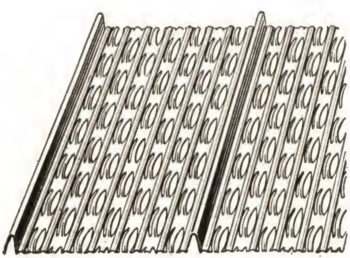


Fig. 39

As the ribbed sheet-metal lath is made usually with a rib at each edge, the sheets are lapped only the width of the rib. Staples should be used over the ribs, the length of the staple being about 1 inch more than the height of the rib.

Wire lath is not made with ribs as is done with expanded-metal or sheet-metal lath, and so it must be supported on furring or studding of metal or wood.

41. Application of Ribbed Metal Lath.—Joints between sheets of ribbed lath are formed by lapping the edge of one sheet over that of the sheet previously applied. The edges are then wired together, or the ribs are clinched together by means of a special punch. The sheets are then secured to the supports by means of wires, staples, or special clips. Where the ends of the sheets occur over supports, the lap is usually made 2 inches, otherwise a lap of 8 inches should be made, and the sheets wired together.

Ribbed forms of expanded-metal lath are adapted for use as a combined furring and lathing on masonry walls, as shown in Fig. 6. When used as bases for plaster to protect woodwork

against injury by fire, the ribs are fastened to the wooden supports, the remaining part of the lath being separated from the wood surface.

42. Lath for Solid Partitions.—To economize space, partitions between rooms or offices are sometimes made as thin as possible. In Fig. 28 the studs *a* are $\frac{3}{4}$ in. hot- or cold-rolled channels. In Fig. 29 at *a* is a **U**-stud, and at *b* an angle stud which forms the jamb of the door. A similar angle forms the head of the door. These studs are fastened to the floor by means of a socket strip *c* and the tops are let into the ceiling. Wooden bucks *d* and *e* are secured to the angle studs by means of screws or bolts. Metal lath is stretched over the studs, the strips being placed horizontally. Grounds to which the base board may be fastened are shown at *f* and *g*. These grounds are placed on both sides of the metal lath *h*, and are nailed through into each other. The grounds *i* and *j* provide nailing places for a chair rail and for a picture molding. Upon this base the plastering is applied on both sides, and brought to the faces of the grounds.

PLASTER BOARDS AND PLASTER LATH

43. Description.—Sheets of various materials used as a base for plaster are known as *plaster board*, *plaster lath*, *plaster base*, and by various trade names. These boards may be made of alternate layers of gypsum plaster and felt, or of a single core of gypsum plaster contained between sheets of strong fibrous felt or paper. Boards made of cork, asbestos, wood, or other fibers are also used. Plaster boards are made from $\frac{3}{8}$ inch to 1 inch in thickness, and from 16 by 32 inches to 32 by 48 inches in size.

The felt or fiber surface of the board forms a perfect bond with the plastering. The boards can be readily sawed and nailed, and are fastened directly to the studs, furring, or joists, with flat-headed nails which are coated to prevent corrosion. The boards are set about $\frac{1}{4}$ inch apart at the edges, and should break joints horizontally, and should be nailed every 6 inches along the edges.

44. Advantages of Plaster Boards.—Plaster boards and plaster lath are non-conductors of heat and cold, and are fire-resisting. They are applied rapidly to walls, ceilings,

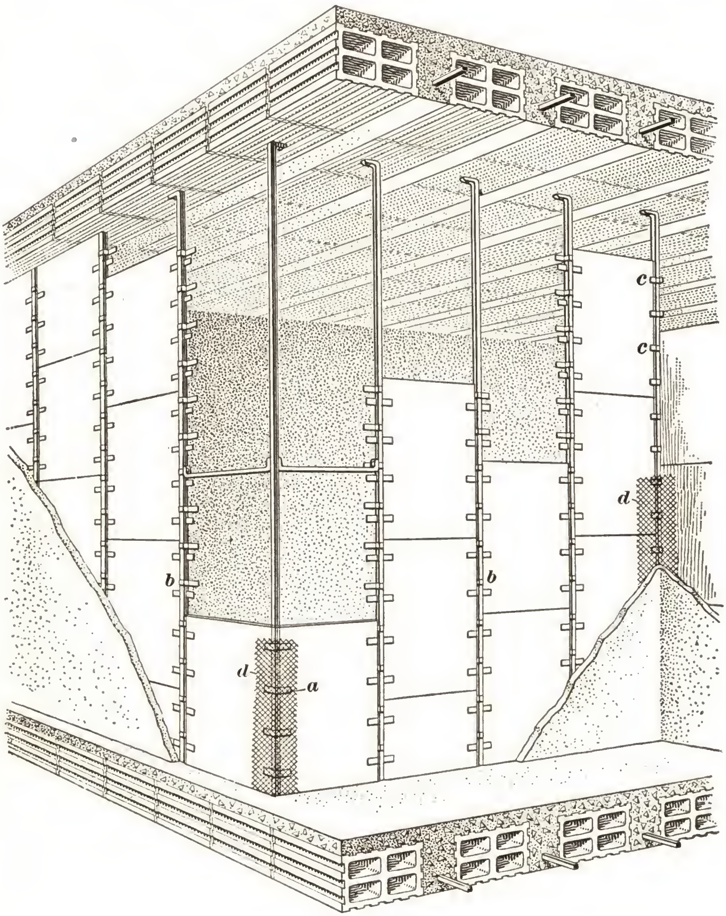


Fig. 40

and partitions, and when in place are immediately ready for the application of the scratch coat of plaster.

Some plaster boards are made with finished surfaces of paper, the core being one or more layers of gypsum plaster.

Such boards are designed for wall covering, without the addition of plaster, so as to produce a paneled effect. The joints may be covered with wooden strips or else filled with a gypsum plaster, and the entire surface papered. These boards are made 32 and 48 inches wide, and from 6 to 16 feet long.

45. Solid Partitions.—Solid partitions may be made by fastening the plaster boards to channel supports, as shown in Fig. 40. The sheets commonly used for this purpose are 24 inches wide and 32 inches high. Clips, as shown in Fig. 41,

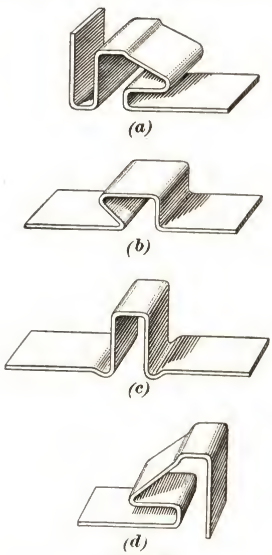


FIG. 41

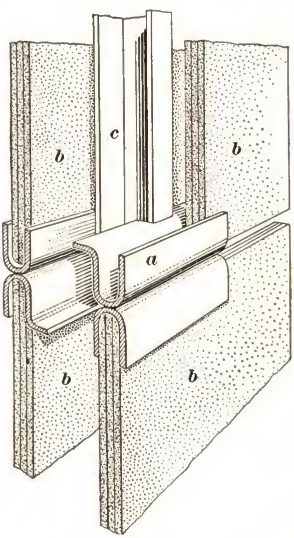


FIG. 42

are used to fasten the boards firmly to the supporting channels. The clip (*a*) is a corner clip, used in places as at *a* in Fig. 40. The clips (*b*) and (*c*), in Fig. 41, are used together in the plain surface, as at *b* in Fig. 40. Clip (*d*), Fig. 41, is used against walls, as at *c* in Fig. 40. These clips are spaced about 6 to 8 inches apart. To minimize shrinkage at corners, metal lath may be bent into angles or over corners, as at *d*, Fig. 40.

46. Hollow Partitions.—Hollow partitions may be built by nailing plaster boards to both sides of wooden

studding. When the studs are of metal, the boards may be held in place by clips. Fig 42 shows a portion of such a partition, the clip *a* holding the boards *b* to the channel stud, *c*.

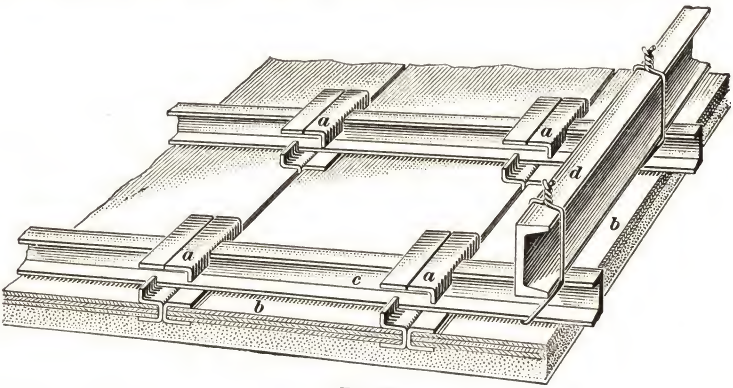


FIG. 43

47. Suspended Ceilings.—Plaster boards may be used for suspended ceilings by the use of clips *a*, in Fig. 43, which hold the boards *b*, the clips being attached to channels *c*, suspended at 16-inch centers from the carrying channels *d*.

INTERIOR PLASTERING

PLAIN PLASTERING

48. Preparation for Plastering.—The carpenters' specifications require, usually, that all surfaces shall be properly prepared for lath and plaster, and that suitable plaster grounds, such as are shown in Figs. 1 and 8, and at *a* in Fig. 44, shall be affixed to the masonry, or framework. Before plastering, the plasterer should test the alinement of the walls and ceilings, to see if there are concave surfaces which will require the application of an excessive thickness of plaster to bring the plaster to a plane surface. Also, to find out if there are places where the lath come too close to the finished surface, so that only a very thin coat of plaster can be applied. Where these irregularities occur, the lathing

should be removed, and the surfaces brought to true planes by blocking out, or cutting back, the furring strips under the lath.

Metal lath should be examined carefully to see that it is rigid, so that it will not buckle when the plaster is applied. The joints should be inspected to see that they are all properly fastened. The lath should be laid so as to afford a secure hold for the plaster, and the weight and finish of the lath should be checked to see that they are in accordance with the architects' specifications.

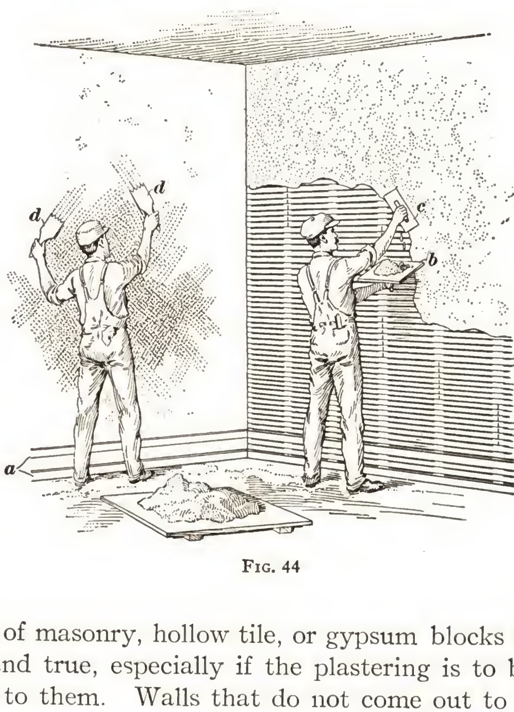


Fig. 44

Walls of masonry, hollow tile, or gypsum blocks should be plumb and true, especially if the plastering is to be applied directly to them. Walls that do not come out to their true planes may be made to do so by means of Portland cement mortar or gypsum plaster.

Plastering on wooden lathing should be begun as soon as possible after the lathing is completed. When such lathing stands too long, it is apt to dry out, making it necessary to wet the lath before plastering can be done.

When gypsum or cement plaster is to be applied to wooden lath, the lath, unless they are green, should be well watered, not merely sprinkled, a few hours before plastering, so that the lath will swell before the plaster has begun to set. When the lath are too dry, they will absorb moisture from the plaster, and swell after the plaster has begun to set, causing the plaster to crack and check.

Masonry surfaces, such as brick, concrete, tile, or gypsum blocks, upon which plastering is to be applied, should be brushed to remove all traces of dust, dirt, or loose particles, and sprinkled with water before applying the plaster. Too much moisture will prevent the proper adhesion of the plaster while, if too little is used, the walls will absorb too much water from the plaster, which then will dry out too fast. A good rule is to have the masonry as wet as it can be and leave no water standing on the surface. Whenever possible, in old work, the mortar joints of the masonry should be raked out to form a key for the plaster. In new work, it is necessary only to leave the joints roughened with the trowel but not struck.

49. Protection from Weather.—After it is on the wall, it is sometimes necessary to give the plaster protection from the weather, if the permanent sash are not in place. In hot, dry, and windy weather, plaster should be protected from air currents by closing the windows with muslin screens. With some quick-setting plasters, the surface should be sprinkled with water to prevent the plastering from drying out too much before it has set. In freezing weather, plaster must be protected from frost until it has set, or become hard. Usually, unless the regular sash are in place, it is the duty of the carpenter to close temporarily all of the openings in the outside walls with old sash, cloth screens, or other suitable materials. Temporary heat is also an advantage in cold weather. This can be easily provided if the heating apparatus of the building is installed. After the plastering has set, the doors and windows should be kept open, if the weather is not too cold, so that the plastering will thoroughly dry out.

PLASTERERS' TOOLS

50. The implements used by the plasterer are simple and inexpensive, the principal ones being shown in Fig. 45.

In (*a*) is shown an ordinary *screen*, which is used for separating the coarser particles of sand and gravel from the finer ones. In (*b*) is shown a screen through which slaked lime is passed to free it from gritty and unslaked particles.

51. The *hoe* and the *shovel*, shown in (*c*) and (*d*) respectively, are used for mixing the materials.

52. The *hawk*, shown in (*e*), is a piece of board about 10 inches square, provided with a short handle. It is used to hold small quantities of plaster, ready for applying with a trowel.

53. The ordinary *laying trowel*, shown in (*f*), is used for applying plaster to the walls. It is a thin plate of polished steel, about 10 inches long and 4½ inches wide, having a wooden handle. Various other forms of trowels, for gauging, pointing, etc., varying in length from 3 to 7 inches are shown in (*g*), (*h*), and (*i*).

54. *Floats* are used for smoothing, or *floating*, the surface of the second coat. In (*j*) is shown the *hand float*, which is merely a piece of board with a handle on the back. It is made usually of pine, but for producing the finished surface of very fine work, a cork face is sometimes used. For rough finish, the face of the float is covered sometimes with burlap, felt, or carpet. A *two-handled float*, called a *derby*, is shown in (*k*); this is a straightedged piece of wood, usually from 3 to 6 feet long, used for floating larger surfaces than can be worked readily with a one-handled float.

55. The *straightedge*, shown in (*l*), is a long piece of smooth board, having its under edge planed straight and true. It is used to test the walls and ceilings, in order to obtain plane surfaces.

56. The *square*, shown in (*m*), is used for testing the trueness of angles.

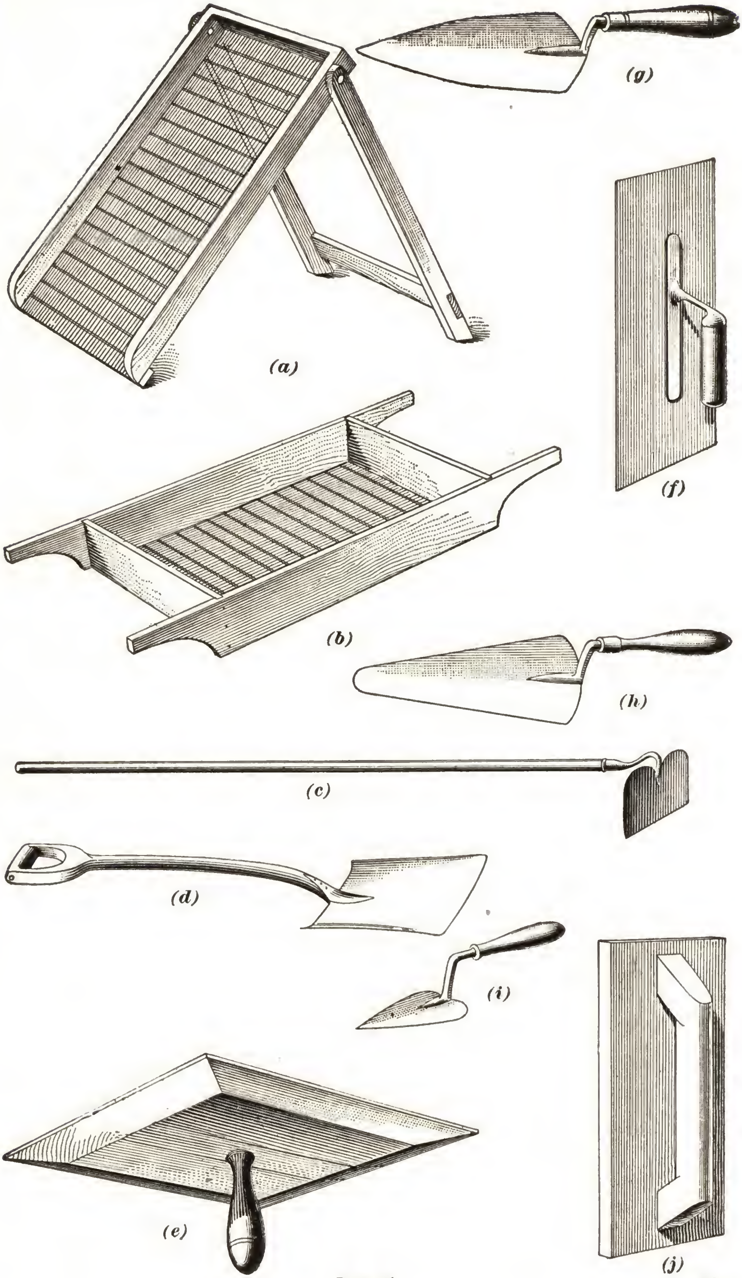


Fig. 45

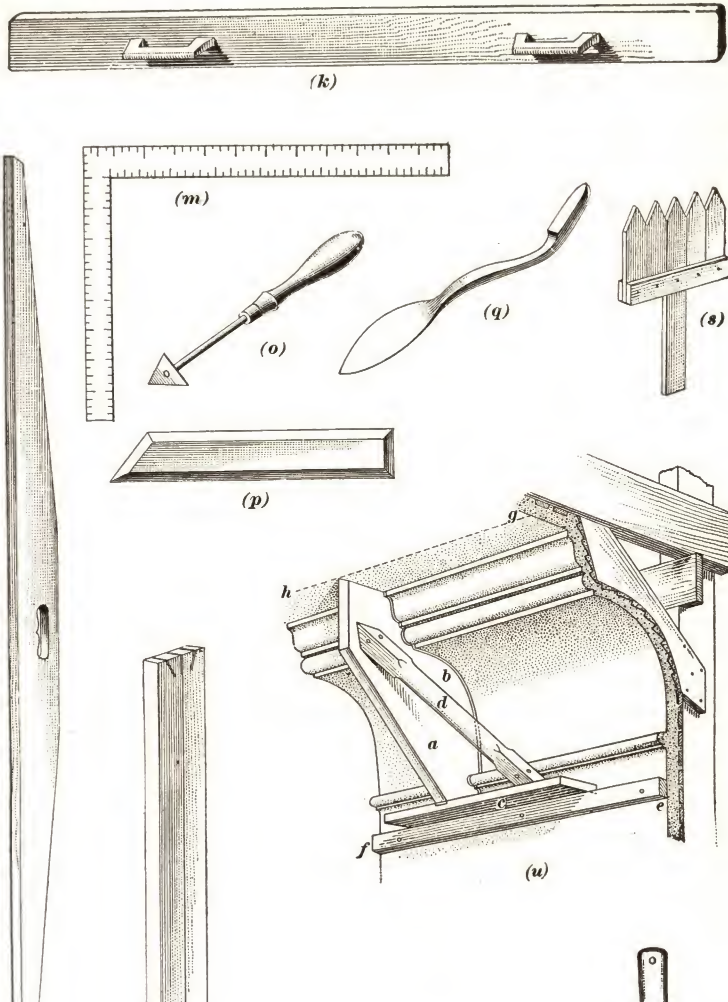


FIG. 45

57. The *plumb*, shown in (*n*), is used to determine whether or not the plastered surfaces are plumb by applying one of its straight sides to the surface. If the plumb-line, hanging freely, lies along a shallow groove cut in the face, parallel to the sides, the surfaces are true.

58. *Jointing and mitering tools*, shown in (*o*), (*p*), (*q*), and (*r*), are used for picking out and finishing angles and miters in moldings, etc.

59. The *comb*, shown in (*s*), is used for scratching the surfaces of the first and second coats of plaster, to form a good key for the ensuing coat. It consists merely of pieces of lath nailed together, and having one end sharpened, as shown.

60. *Brushes* of various kinds are used by the plasterer. That shown in (*t*) is used for dampening the surface of the plaster while it is being worked smooth.

61. *Templets* of various kinds are used for forming cornices and moldings. The templets are made of wood or sheet metal cut to the required outline, and are backed by wood. In (*u*) is shown one form of templet, which consists of a board *a*, to the beveled inner edge of which is attached a thin zinc or steel plate cut to the outline of the cornice, as at *b*. The strip *c* and the handle *d* brace the board *a* firmly and keep it square with the wall; *e f* represents a guide strip on which the strip *c* slides, and *g h*, a line drawn on the ceiling, flush with the outer edge of the board *a*, which is kept along this line. The frame of this templet, consisting of the pieces *a*, *c*, and *d*, is known sometimes as a *horse*. Templets are made either right-hand, as shown, to be pushed from right to left with the right hand, or left-hand, to be pushed from left to right with the left hand.

LIME PLASTER

62. Definition.—*Lime plaster* is a form of plaster the principal ingredient of which is lime. The lime is mixed with sand, hair, and water to form a plaster which is applied to the wall, or to the lathing. The finishing coat of plaster consists of lime, plaster of Paris, and sometimes marble dust.

63. Characteristics.—Lime plaster hardens gradually as the lime in the plaster absorbs carbon-dioxide gas from the air. Lime plaster requires considerable time to become thoroughly hardened. This, however, has certain advantages, as it gives the plasterer more time to true up his work, and the mortar can be retempered without destroying its efficiency. When properly made with good lime, lime plaster forms a serviceable wall, and is sometimes preferred to gypsum plasters.

64. Lime.—There are many kinds of lime on the market and care should be exercised in selecting the one to be used. Lime is generally slaked at the building, which requires time and space. It should be thoroughly slaked so that there will be no unslaked particles of lime in the plaster. If unslaked particles occur in the plaster they are apt to slake after the plaster has been placed on the wall and force pieces of plaster off the wall. This is known as *popping*, or *pitting*.

When the lime is slaked it is generally in the form of a paste, called *lime paste*.

65. Hydrated Lime.—In place of lump lime, hydrated lime may be used. Hydrated lime is lime that has been slaked by machinery. Hydrated lime is used extensively in the preparation of the first and second coats of lime plaster, and some especially prepared brands are used in the mixture for the finishing coats of plaster, and in ornamental work. Wherever lump lime can be used in the various plaster mixtures described in the succeeding articles, hydrated lime may be used, and the time and space required for slaking the lime can be saved.

66. Coarse Stuff.—Coarse stuff is used for the first coats of plaster, and is made by mixing the proper quantities of sand and well beaten hair with lime paste.

67. Fine Stuff.—Fine stuff is used in the preparation of the finishing coat of plaster. It consists of lime paste that has been diluted with water until it is as thin as cream. The substance is then allowed to settle. When the surplus water

appears clean and the lime held in suspension has settled, the water is drained off. The moisture in the mass is then allowed to evaporate until the paste becomes sufficiently stiff for use.

68. Plasterers' Putty.—Plasterers' putty, or lime putty, is practically fine stuff except that the creamy fluid has been strained through a fine sieve. This makes the paste much more velvety than fine stuff.

69. Gauged Stuff.—Gauged stuff for the finished coating of walls and ceilings consists of about three-fourths fine stuff or plasterers' putty, and about one-fourth plaster of Paris. The plaster of Paris causes the mixture to set quickly, and the mixture must be used immediately. No more should be prepared than can be applied in 20 or 30 minutes.

70. Hair and Fiber.—Hair and fiber are used in plaster for the reason that plaster does not possess sufficient cohesive power to bind it together firmly until it has hardened or set. Hair is used largely for this purpose. Cattle hides are the chief source from which plastering hair is obtained. After being cleansed of all grease, the hair is washed and dried, and packed into bags that hold a bushel, measured loose, and weigh from 6 to 8 pounds.

Manila fiber is probably the best, but it is somewhat expensive. Sisal, obtained from a species of cactus, is an excellent fiber and is frequently used. Cottonwood and coconut fiber are also used, although much bulkier than hair. Gypsum plasters usually contain either Manila, jute, wood, or asbestos fiber as a binding material.

71. Water.—Water used in the preparation of plaster should be clean and free from oil, acid, strong alkalis, or vegetable matter. Such substances affect the strength of the plaster as well as the rate of setting.

72. Sand.—Sand for plastering should be angular, of medium fineness, and clean, but above all it should be graded from fine to coarse in size of particles. Before using, all sand should be screened to remove the too coarse particles,

and, if wanted for use in the finishing coat of plaster, it should be passed through a fine sieve. The best plaster is made from screened, washed, and dried sand. White sand is used sometimes to give a firm, white surface to the finishing coat of plaster, and marble dust is used for the same purpose.

73. Quantities of Materials Required.—The scratch and brown coats of lime plaster together, when laid on wood lath having $\frac{3}{4}$-inch grounds, will require about 600 pounds of lime, 3,600 pounds of sand, and 24 pounds of hair, or 16 pounds of hair and 8 pounds of fiber for 100 square yards of surface. Metal lath will require about 700 pounds of lime, 4,200 pounds of sand, and 28 pounds of hair for the two coats for the same area. The quantities given are approximate only, as lime and sand vary in different sections of the country.

GYPSUM PLASTER

74. Definition.—*Gypsum plaster* is a form of plaster, the principal ingredient of which is gypsum. It is a quick-setting, hard, plaster which is delivered at the building in a dry state and is made ready for use by the addition of water, or sand and water.

Gypsum plasters are also known as *cement plasters*, *patent plasters*, *prepared hard plasters*, and *hard wall plasters*.

75. Manufacture.—Gypsum plasters are made of gypsum rock which is found in many parts of the world. This rock is ground and calcined, or burned, and some of the water in its composition is driven off. The product is then mixed with a binder and a retarder. The binder consists of hair or fiber to give tenacity to the plaster while setting. The retarder is a material that is added to prevent the plaster from setting or getting hard too quickly. These materials are weighed and thoroughly mixed together by machinery, thus assuring a uniform product.

Gypsum plaster is put up in jute bags containing 100 and 125 lb., in paper bags containing 80 lb. and in barrels containing from 250 to 300 lb.

After the plaster has been used, the jute bags, if in good condition, can be returned to the manufacturer and a credit obtained for them.

76. Characteristics.—The product is uniform in quality and when mixed and applied according to the directions given by the manufacturers, produces dependable results. Gypsum plasters, like Portland cement, set quickly, whereas lime plastering hardens gradually by contact with the air. The quick setting of hard plasters permits the application of succeeding coats in a very short time, thus permitting a saving in time. Walls made of these plasters are very hard and strong compared with walls covered with lime plasters, and are fire resisting. In large buildings the dry materials may be distributed about the building, the adding of water and the mixing being done near the place where the plaster is to be applied.

77. Forms of Hard Plasters.—Gypsum plasters are made and sold in various forms, such as *neat*, or unsanded; *prepared*, or *sanded*; *wood fiber plasters*, and *bond plasters*.

Neat, or unsanded, plaster contains no sand and both sand and water must be added in the proper proportions to make it ready for use. When good sand is found in the neighborhood of the building that is being plastered, neat cement can be ordered to advantage and sand added at the building. This form of gypsum plaster is most generally used. Care should be taken not to add too much sand to the plaster as it is delivered in the package. The manufacturers usually stipulate the amount of sand that should be added.

Prepared, or sanded, plaster is neat plaster to which a proper amount of sand has been added by the manufacturer. Only water is added in preparing it for use. The manufacturer usually has facilities for obtaining sand of a suitable quality and can screen, wash, dry, and mix it with the plaster by machinery. In neighborhoods where good sand cannot be obtained, it is advisable to use the prepared plaster. The cost of sanded plaster is increased by the freight charges when it must be delivered a great distance from the factory.

Wood fiber plasters contain finely shredded wood fiber in place of the sand used in prepared plasters. The wood fiber gives to the plaster elasticity, toughness, lightness and strength. It also makes the plaster easier to apply. It is generally used without the addition of sand, but in some makes of wood-fiber plaster, sand may be added, using one part plaster to one part sand.

78. Bond Plaster.—**Bond plasters,** known as *concrete plasters*, are gypsum plasters manufactured especially for the first, or scratch, coat of plaster on concrete surfaces. These plasters adhere strongly to the relatively smooth surfaces to which ordinary plaster will not hold. They furnish bases to which the regular gypsum plaster will adhere. Bond plasters are sold neat or mixed with sand.

79. Plaster of Paris.—While not a wall plaster, plaster of Paris is used in connection with the finishing of plastered walls and is a gypsum product. It is used particularly in the finishing coat of walls and in ornamental plastering. It is mixed with a certain proportion of lime paste and sand, in forming cornices, moldings, and enrichments as well as for plain surfaces.

Plaster of Paris is unsuited for exterior work, as it is slightly soluble in water. It is mixed with lime paste and with finishing plaster to cause them to set more quickly.

80. Mixing Gypsum Plasters.—Plaster is mixed in a shallow box, one end of which is raised about 4 to 6 in., and the dry materials placed in the high end. Water is placed in the low end of the box, and the plaster hoed down into it, plaster being added until the mass is thoroughly mixed and of the proper consistency. When unsanded plaster is used, sand is added to the plaster and the whole mixed thoroughly while dry. Small quantities should be mixed with water at one time. No more should be mixed than can be used handily in about 1 hour.

81. Proportions.—For ordinary work with unsanded plaster, two parts of sand are mixed with one part of gypsum

for the scratch coat on wood or metal lath, or on plaster boards. Three parts of sand and one part of gypsum are mixed for the first coat on brick, tile, or gypsum blocks, and for the second coat on all walls.

APPLICATION OF LIME PLASTER

82. Names of Coats.—Lime and gypsum plasters are applied usually in three coats, the first being called the *scratch* coat; the second, the *brown*, *straightening*, or *floated*, coat; and the third, the *skim*, *white*, or *finishing*, coat. In some cases two coats only are used, the first coat being straightened and smoothed carefully to receive the finishing coat. On masonry, the separate scratch coat is usually omitted, but when applied is called the *rendering* coat. When combined with the brown coat on masonry, the first coat is called a *scratch-and-brown* coat.

83. Scratch Coat.—The method of applying the scratch coat of lime plaster to wood lath is illustrated in Fig. 44. The plaster, mixed to the proper degree of firmness in the mixing box, is carried to mortar boards, shown on the floor. A quantity of the plaster is placed on the wooden hand board, or hawk *b*, by means of the trowel *c*. The plasterer then takes small quantities of the mixed mortar on his trowel and spreads them firmly and evenly over the surface of the lathing. The plaster should hold together well, and yet be soft enough to be pressed in between the laths, so that it will bulge out behind the laths sufficiently to form a clinch or key. The thickness of the layer should be fully $\frac{1}{4}$ inch in front of the lath so that when it is set it will furnish a rigid surface upon which to apply the succeeding coats. After the first coat has somewhat hardened, it is scratched with comb-like blades *d*, in Fig. 44. From this operation, the first coat is called the scratch coat. The scratches or grooves form a key for the plaster of the next coat.

When a scratch coat is applied to a masonry wall, the plaster should be forced into all the joints and crevices, which serve the same purpose as the openings in the lathing.

84. Brown Coat.—The second, or brown, coat of lime plaster consists of coarse stuff to which a larger proportion of sand and somewhat less hair has been added than was used for the scratch coat. It should be about $\frac{1}{4}$ inch thick, and should be compacted firmly by rubbing with the float *g*, Fig. 46. Should the coat become dry during the process, it is moistened by applying water with the wide brush shown in *t*, Fig. 45.

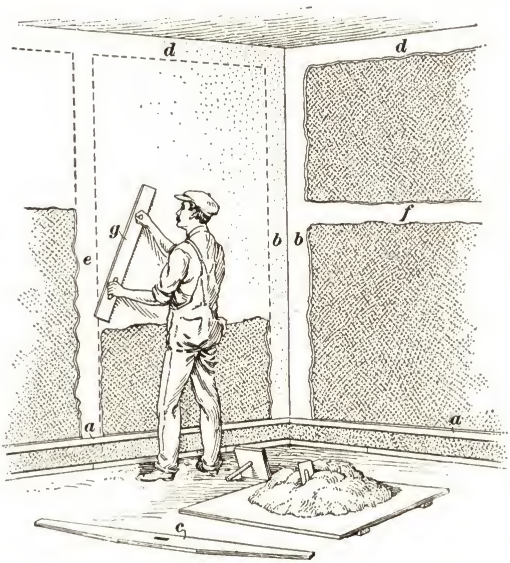


Fig. 46

On masonry walls, the brown coat is built out to the desired plane ready for the finishing coat, with as little rubbing as possible.

85. Green Work, or Laid-off Work.—Sometimes the brown coat is put on immediately after the scratch coat, without allowing time for the latter to dry out. This is known as *green work*, or *laid-off work*. In such cases, the first coat is made very rich in lime, while the brown coat contains a larger proportion of sand. The brown coat is worked into the scratch coat so as to form practically one coat.

Laid-off work is a less expensive form of three-coat work because of the fact that the same scaffolding can be used for the first two coats. The second, or brown, coat can be applied while the first, or scratch, coat is yet fresh.

86. Screeds.—In order to obtain true walls and ceilings, especially in large surfaces, where the grounds are far apart, the process known as *screeding* is employed. *Screeds* are plaster bands made of brown coat material formed on the scratch coat. They are 5 or 6 inches wide, and are shown at *b*, *d*, *e*, and *f* in Fig. 46. The screeds *b* are built up on the scratch coat at the angles, and are plumbed carefully from the grounds *a* by means of the straightedge *c*. They are kept back, however, about $\frac{1}{8}$ inch from the finished face of the grounds, to allow for the finishing coat. The horizontal screeds *d*, are formed at the ceiling angles. Intermediate vertical and horizontal screeds are also made as at *e* and *f*. Screeds are placed usually 4 to 8 feet apart, and form a true plane. The spaces between the screeds are filled in, flush with the screeds, and rubbed down with the two-handed float, or derby *g*.

Ceilings are treated in a manner similar to that used on the side walls, the screeds being leveled carefully.

When the scratch and brown coats are applied as one coat, as already mentioned, the screeds are built out before the panels are filled, the general method being the same as just described.

The space between the plaster grounds *a*, for the baseboards, and the floor, is finished, usually, only with a scratch and a brown coat of plaster.

87. Finishing Coat.—The finishing coat is the one that is visible, and it is made, generally, so as to give a pleasing finish to the wall, and to provide a good surface upon which to apply paint, papering, or other decorations. There are several kinds of finishing coats, known as *skim coat*, *sand finish*, and *hard-finished white coat*. In all cases the material is applied to the surface in the form of a stiff paste by means of the trowel *a*, shown in Fig. 47, and is spread uniformly over the surface of the brown coat to a thickness of about

$\frac{1}{8}$ inch, bringing the finished surface of the plastering out to the lines of the grounds. These finishes should be applied after the brown coat is dry.

88. **Skim-coat finish** consists of lime putty and very fine, white, sand. Usually, a little plaster of Paris is added to hasten the set and to form a harder surface. When the plaster is added, the sand is usually omitted. This mixture is polished to a glazed surface with a steel trowel *b*, the surface being kept moist by water applied with the brush *c*. For

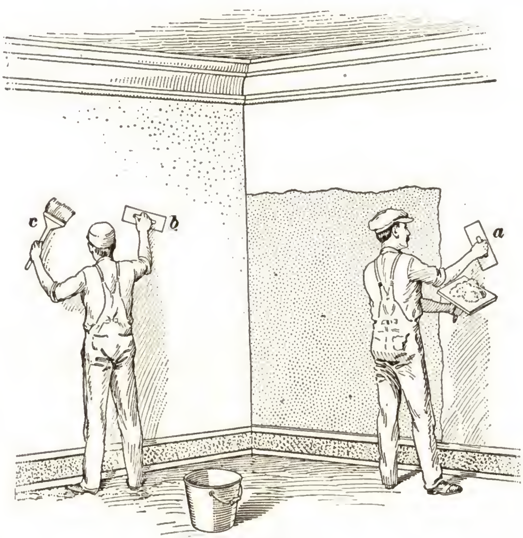


FIG. 47

100 square yards of surface, there will be required about 200 pounds of lump lime or 300 pounds of hydrated lime, 50 to 100 pounds of plaster of Paris, and 50 to 100 pounds of white sand.

89. **Sand finish** consists of gauged lime putty and sand, and is usually finished with a wood- or cork-faced trowel. Sand finishes may be fine or coarse as desired, the finish of the surface being determined by the sand that is used. This surface is sometimes obtained by covering the hand float *j*,

Fig. 45, with a piece of carpet, burlap, or felt, which will cause the sand to rise to the surface and present the characteristic sandpaper finish. About 200 pounds of lump lime, 50 to 100 pounds of plaster of Paris, and 400 to 500 pounds of sand, will be required for 100 square yards of surface.

90. Hard-finished white coat consists of 3 to 5 parts of lime putty gauged with 1 part of plaster of Paris, and to which marble dust or fine white sand has been added. This coating is smoothed and polished with the steel trowel. Marble dust gives a surface susceptible to a high polish. About 200 pounds of lump lime, 75 to 100 pounds of plaster of Paris, and 50 to 75 pounds of marble dust or sand will be required for 100 square yards of surface.

Sometimes the finishing coat is omitted in cheap work, the brown coat being brought to the line of the grounds and made as smooth as possible. This treatment saves the expense of applying the finishing coat of white plaster.

APPLICATION OF GYPSUM PLASTERS

91. The general processes used in applying lime plaster are also used in the application of gypsum plasters. Lime plaster hardens and dries somewhat slowly by contact with the air. It hardens by absorbing and combining with carbon dioxide in the air, and does not become thoroughly hardened for several months.

Gypsum plaster, on the other hand, sets in the same manner as Portland cement, and, although it may still be wet or moist, it may be thoroughly set and hard. The time required for gypsum plaster to set can be regulated by the addition of different substances. The manufacturers arrange the time of setting so that their product will set in a fixed time which will yield the best results. Hence, with gypsum plaster, the second, or brown, coat can be applied over the scratch coat within 2 or 3 hours after the first coat has been applied, even though the first coat is still wet. However, the first coat should be set and hard. The first coat should be scratched before the material has set.

If the first coat is allowed to stand until it is too dry, it should be sprinkled with water before applying the second coat.

The second, or brown, coat, also called the *floated coat* and the *straightening coat*, is about $\frac{1}{4}$ inch thick. The same methods are used in screeding and straightening this coat as have just been described for lime plastering.

Solid partitions are formed by applying a scratch coat and a brown coat to the studding and lathing shown in Fig. 29. The plaster is brought out to within $\frac{1}{8}$ inch of the faces of the grounds, to allow for the finishing coat.

The finishing coats described for lime plastering may be applied to gypsum brown coats. Manufacturers supply ready-mixed finishes for use with their plasters. They also give directions for their proper use, and for finding the quantities of materials required.

KEENE'S CEMENT

92. Keene's cement is made by recalcining plaster of Paris which has been saturated with a solution of alum. When properly applied, the material becomes very hard and takes a high polish. Its hardness makes it a satisfactory material to use for finishing the lower portions of walls where the surface is liable to injury, as in kitchens and bathrooms. In such cases, the surfaces of the plaster are marked off with lines to imitate the joints of tile work.

93. Keene's cement is made in four grades, as follows: *Regular*, for general plastering purposes; *fine*, for wainscots, columns, extra white finish, and for backing artificial marble; *superfine*, for facing artificial marble; and *quickset*, for castings and moldings. The regular grade is commonly used for plastering the plane surfaces which occur in ordinary work.

94. Application.—Keene's cement may be applied on brick, stone, concrete, hollow tile, or gypsum blocks, or to wood or metal lath. The general methods and the tools used for lime or gypsum plastering are employed in applying Keene's cement plaster.

The first, or scratch, coat of Keene's cement plaster is mixed in the proportions of 1 cubic foot of Keene's cement, 1 cubic foot of dry hydrated lime, 5 cubic feet of sand, and about $\frac{3}{4}$ bushel of hair. The first coat should be well scratched and allowed to harden before the second is applied.

The proportions for the second, or brown, coat are: 1 part of Keene's cement, 1 part dry hydrated lime, and 7 parts sand. This coat should be allowed to dry before the final, or finishing, coat is applied.

95. Finishes.—The finishing coat of Keene's cement may be one of three, known as *smooth* finish, *sand-float* finish, and *smooth-hard* finish. Any one of these three may be applied to gypsum plaster or lime plaster brown coats, to a Portland cement base, or to the second coat of Keene's cement.

To secure the smooth finish, the finishing coat is composed of 4 parts Keene's cement, to which is added 1 part of dry hydrated lime. When nearly set, the coat is troweled to a smooth polished surface.

The sand-float finish is obtained by mixing 1 part of Keene's cement with 1 part of dry hydrated lime, and not more than 7 parts sand. The surface is brought to the desired finish with a wood or cork float. The texture and color of the sand used will appear in the finished surface.

For the smooth hard finish, Keene's cement is used neat, that is, without the addition of either lime or sand. The finish coat is troweled to the desired finish.

All the above are mixed with suitable quantities of clean water.

PORTLAND CEMENT PLASTER

96. Portland cement plaster is used mainly on account of its hardness, and for its fireproofing and water proofing qualities. This plaster requires only a few hours to set, and in setting it combines with the water used in mixing. One or two days' interval between the application of the coats is all that is required.

97. Materials.—The materials used in making Portland cement plaster are Portland cement, sand, hydrated lime, and water. In some cases a special waterproofing material is added. The hydrated lime has a waterproofing value, and it is used also to give the mixture smoother working qualities.

98. Proportions.—The usual proportions for Portland cement plaster are 1 part Portland cement $\frac{1}{10}$ part hydrated lime, and $2\frac{1}{2}$ parts sand.

99. Application.—Portland cement plaster is applied usually in two or three coats, each coat being applied in thin layers and built up to the full thickness. No more plaster should be mixed than can be applied in 20 or 30 minutes, as the plaster should not be applied after it has begun to set. Each coat should be scratched and allowed to set, but not to dry, before the next coat is applied.

100. Finishes.—Either of two finishes, known as *smooth-troweled* and *stippled*, may be given to the final coat of Portland cement plaster.

The smooth-troweled finish is secured by allowing the cement to harden partly, but not to acquire its initial set. The surface is then troweled smooth with as little rubbing as possible. Too much rubbing is apt to bring the water and cement to the surface, resulting in an unsatisfactory finish.

A stippled finish may be given the surface by first troweling as is done for a smooth-troweled finish. While the surface is still moist, it is patted lightly with the end of a brush of broom straw.

CAEN STONE CEMENT

101. Natural Caen stone, found in France, possesses a texture and color that is very pleasing and satisfactory for interior decoration. It is crushed and mixed with special cements and chemicals and applied in the form of plaster to the interior surfaces of walls. It is generally used to imitate the stone from which it is made. After it has been applied to walls, imitation joints are cut in the surface and are filled with Keene's cement. This treatment results in a fine creamy

limestone effect that is extremely attractive. Moldings are run in the same manner as is done with plaster. The surface is sometimes scratched to represent 8- or 10-cut limestone work, or it may have a rubbed finish. The Caen stone cement is applied over a base of Keene's cement plaster and is about $\frac{1}{4}$ inch thick. It is brought to a true surface in the same manner as standard plaster. After the joints have been finished, the whole surface is rubbed smooth with sandpaper. The work of applying and finishing Caen stone requires high-class workmanship and experience.

ORNAMENTAL PLASTERING

MATERIALS AND PREPARATION

102. Definition.—As already defined, ornamental plastering is the art of forming ornament in plaster on plain surfaces. This ornament is in the form of moldings, cornices, paneling, pilasters, and other architectural and decorative features which add to the interior of a building.

103. Materials.—The principal materials used for ornamental plaster work are plaster of Paris, lime paste, and some of the finer kinds of gypsum plasters. The tools used for forming the ornament have already been described.

104. Cornices and moldings are run by the plasterer as will be described later. Ornaments, columns, pilasters, and sometimes moldings are cast at the shop and brought to the building ready to be set in place. Other ornaments are manufactured and kept in stock and are ordered from catalogs or samples. These also are brought to the building and set in place by the plasterer.

105. Preparation for Moldings and Cornices.—Cornices and moldings are made, or run, in place, usually before the finishing coat is applied. Where the extreme projection of the molding or cornice is less than 2 inches from the finished wall, or ceiling, the core is formed of coarse stuff, or of brown

coat. The finished surface of the cornice is formed by running a thin coating of finishing material over this core.

106. When the projection of the cornice is several inches, a base of wood blocking is formed to which lath is attached, and this base is coated with the scratch and brown coats. This rough plastering is brought within $\frac{1}{4}$ inch of the finished surface and upon this base the finishing coat is run so as to produce the desired cornice.

107. In Fig. 48 is shown a cornice of small projection, which is run against the brown coat of the wall *a* and ceiling *b*. A core *c* is run with a muffled templet, described later, and

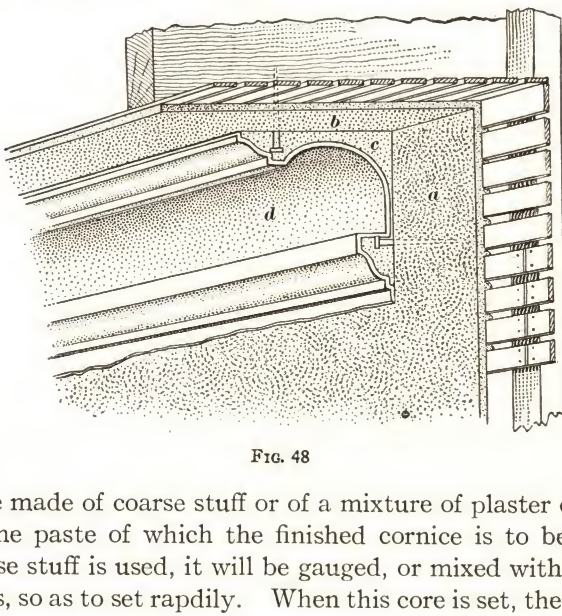


FIG. 48

may be made of coarse stuff or of a mixture of plaster of Paris and lime paste of which the finished cornice is to be made. If coarse stuff is used, it will be gauged, or mixed with plaster of Paris, so as to set rapdily. When this core is set, the cornice *d* will be run in finishing plaster and plaster of Paris and will form a true, clean, cornice.

108. The cornice in Fig. 49 can be run directly on the brown coat *a*, the thicker part *b* being formed of the finishing plaster of which the cornice is made. The picture molding *c* is placed so that it forms part of the cornice.

109 In Fig. 50, the base of the cornice is formed by nailing a strip of metal lath in the angle of the wall and ceiling so as to form a core. This lathing is applied before the plastering is started and is plastered with the first two coats when the remainder of the wall is plastered. The strip *a* is nailed on the ceilings to form a base for the projection *b* of the cornice. The cornice is shown in section at *c* and is run directly on the brown coat *d*. At *e* and *f* are shown the guides that are used in directing the movement of the templet used in forming the cornice.

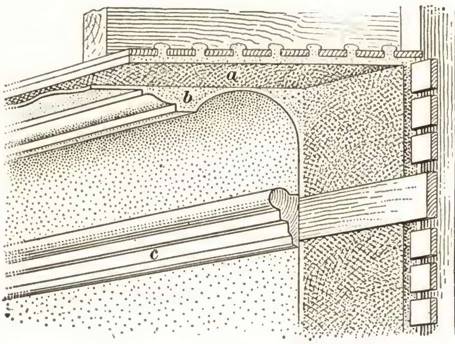


FIG. 49

110. In Fig. 51 is shown a cornice with a considerable projection. It is *blocked out* with blocks *a* nailed to each joist above, or about 16 inches on centers. To this blocking the lathing is nailed and the entire lathed surface is coated with scratch and brown coat as shown at *b*. Upon this surface the finished cornice *c* is run.

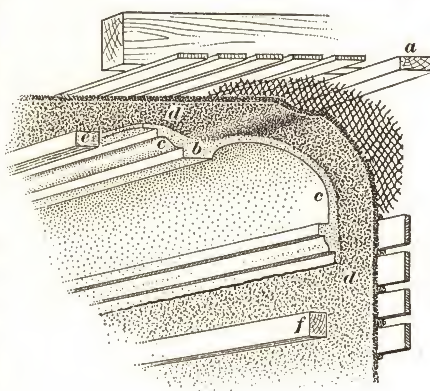


FIG. 50

111. Preparation for Curved Ceilings. Curved ceilings often require an intricate framing of light iron or steel in order to support properly the metal lath on which the plaster and ornamental work is applied. Fig. 52 shows the furring necessary to form the large sweep of the

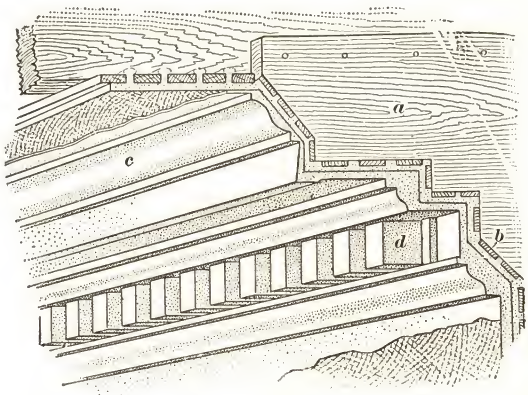


Fig. 51

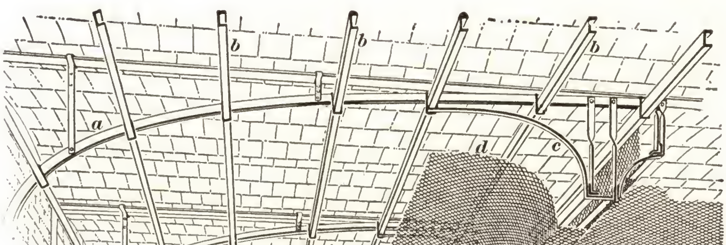


Fig. 52

coved ceiling and the ornamental cornices and beams. The curved bars *a* support the channels *b* and *c*, to which the metal lath *d* is attached. When this lathing is all applied, the plastering is carried on in the usual manner. In a ceiling such as the one shown, considerable ornamental plasterwork would be supported on the wire lath.

112. Curved surfaces may be formed in ribbed-metal lath when the construction requires a stiffer surface than will be furnished by the plain lath alone.

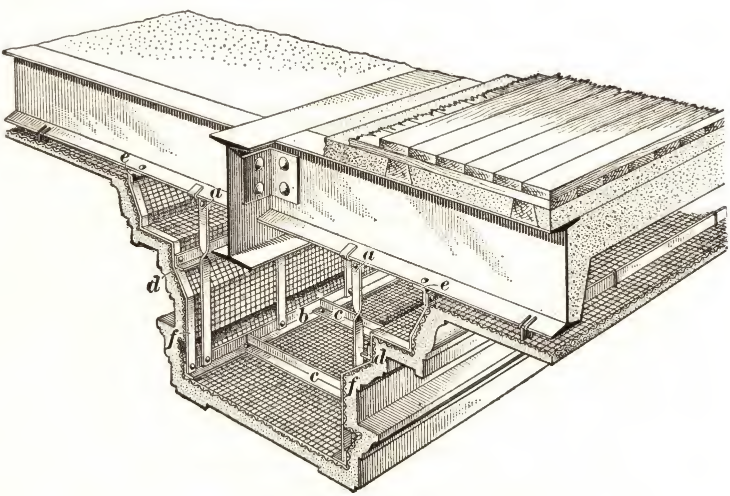


Fig. 53

113. Preparation for False Beams.—An elaborate beam construction is shown in Fig. 53. This is typical of work in fireproof buildings, where the use of wood must be reduced to a minimum. In this construction the hangers *a* are connected to horizontal angle bars *b*. This angle and a similar one on the other side of the beam are connected and braced by means of the cross-piece *c*. Other angle bars are shown at *d* and *e*. At *f* are shown flat bars that are formed to the approximate outline of the cornice, and which are supported by the horizontal angles. The angle bars *e* are

attached directly to the structural beams of the ceiling. This entire construction is enclosed by wire lath to which the ornamental plastering, as shown, is attached.

APPLICATION OF THE PLASTER

114. Running Cornices.—Upon bases formed as just described, plaster cornices are run. Cornices are run before the finishing coat is put on. Longitudinal strips are attached to the wall, as shown at *e* and *f* in Fig. 50, or at *b*, Fig. 54, on which a templet *a* is run. Sometimes a strip is attached also to the ceiling, but more often the ceiling guide is merely a line.

FIG. 54

If coarse stuff is required, it is made to conform to the approximate profile with a muffled templet, that is, by forming a layer of plaster of Paris about $\frac{1}{8}$ inch in thickness along the edge of the templet; or an extended profile can be cut out of zinc and attached temporarily to the correct templet. The templet is placed in position and is pushed along the angle of

the wall. When the coarse stuff has had time to dry, the surface is coated with gauged stuff and worked over carefully with the correct templet until an exact and perfect finish is obtained.

115. Corners and intersections, which cannot be run on the wall, are molded and mitered by hand on the wall, using the tools shown at *o*, *p*, *q*, and *r* in Fig. 45. The plasterer extends the surfaces until they meet at a neat angle. Another way in which the cornice is formed is to run sections of the cornice on a bench, and attach them to the wall by means of a thin mixture of plaster of Paris and water. The internal and external miters are cut on certain sections and set in place.

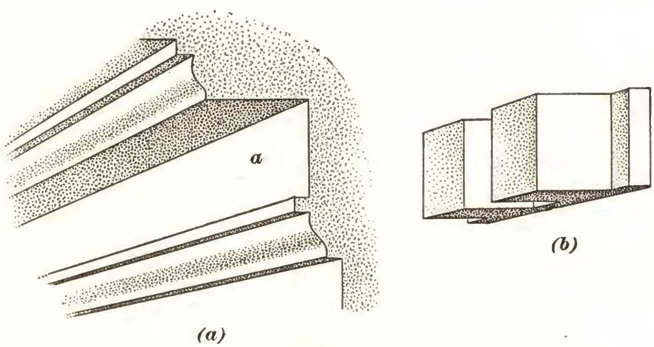


Fig. 55

The joints are then touched up by the plasterer. When this method is followed, the corner is put up first, and the remaining cornice is run to it.

A cornice such as shown in Fig. 51 cannot be run complete on account of the dentil course shown at *d*. The cornice is run without the dentils and the dentils must be cast separately and placed in a recess as shown at *a*, Fig. 55 (*a*). The dentils are cast in lengths (*b*), and stuck in place by means of thin plaster of Paris.

116. Centerpieces.—Circular centerpieces consisting of plain moldings are formed in the same manner as run cornices, except that the mold, or templet, is so fastened as to swing around the center of the ornament. Decorated centerpieces

are usually cast in a mold and are stuck on the ceiling with thin liquid plaster of Paris.

117. Ornamental Ceilings.—Nearly all kinds of ornamental plastering on ceilings, such as moldings, bas-relief, imitations of foliage, etc., may be formed of plaster of Paris. In paneled ceilings, the ceiling is first marked to show the location of the moldings which are to form the design. The moldings are then cast, or run, and cut by a saw into the required lengths with mitered ends for the points of intersection. All the intersections should be carefully pointed with plaster of Paris, and smoothed with a tool to secure perfect joints in all parts of the work.

In Fig. 56 is shown a portion of an ornamental plaster ceiling in which the design is made up mainly of molded members and leaf-like finials. Very shallow and delicate forms of cast-plaster ornaments are made by pouring the plaster of Paris into a mold, and while the plaster is still soft, pressing a canvas backing into it. This canvas with the plaster ornamentation attached is then applied to the plastered surface, joints being formed at such places as can be easily pointed and concealed.

The liquid plaster which is used to attach cast-plaster ornaments to the ceiling is usually a sufficient fastening for small moldings and ornaments. For large moldings and ornaments, however, it is customary to apply wooden grounds to the ceiling framing before the plastering is done, and the plaster moldings are nailed to these grounds.

118. Applied Ornamentation.—A great variety of plaster ornaments, such as corbels, brackets, sculptured panels, ceiling ornaments, friezes, bands, rosettes, and center-pieces, may be obtained from companies making a specialty of such work. For some designs, these ornaments may be made of plaster of Paris, while in other designs the material may be of a special composition made of ground chalk, paper pulp, wood fiber, glue, and other substances. Ornaments of this composition are tougher and lighter than those cast in plaster, and they can be obtained in sizes and shapes which

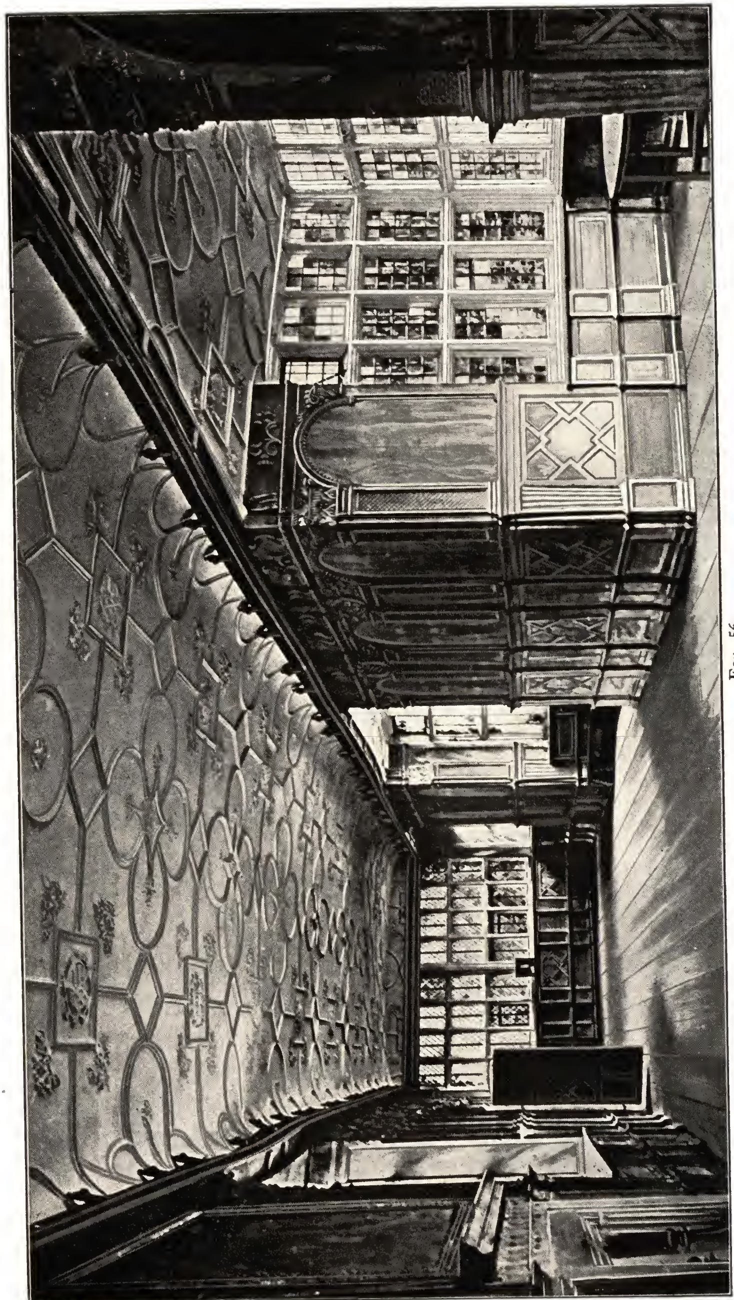


Fig. 56

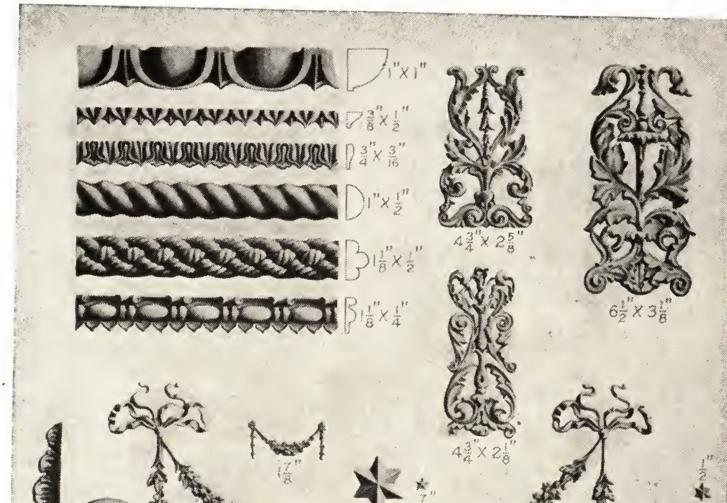

1"x1"
3/8"x1/2"
3/4"x3/16"
1"x1/2"
1 1/8"x1/2"
1 1/8"x1/4"
4 3/4"x2 5/8"
6 1/2"x3 1/8"
4 3/4"x2 1/8"
1 7/8"
7/16"
1/2"
1/4"
12 1/2"x5 1/2"
4 1/2"x3"
3"
4"
5"
5"

Fig. 57

Fig 58

can be built into practically any design. Fig. 57 shows a number of such ornaments as they are furnished by the manufacturer. The size is marked beside each.

119. In Fig. 58 is shown the application of ornamental plastering to a dining-room in a modern hotel. In this work the piers were plastered square on gypsum blocks, while the beams were plastered on metal lath furred out to the required shape. The ornamentation, in the form of panels, rosettes, consoles, moldings, and cartouches were fixed in place with plaster of Paris. This figure illustrates the use of ornamental plastering to represent solid architectural forms, such as columns, piers, brackets, etc. Elaborate architectural effects can thus be produced by the use of ornamental plaster, at a smaller cost than if made of stone or expensive hard woods.

EXTERIOR PLASTERING

STUCCO

KINDS AND ADVANTAGES

120. General.—As has been stated, the term *stucco* is applied to plaster used on the exterior surfaces of walls. Stucco should be composed of materials that will stand exposure to heat, cold, and water, and thus form a durable outer covering for the building.

121. There are two kinds of stucco, distinguished by the different materials that enter into their composition. *Lime stucco* consists principally of lime, sand, and aggregates. *Portland cement stucco* consists of Portland cement, sand, lime, and aggregates. Usually coloring and water-proofing materials are added to give the desired color and to prevent the absorption of water.

122. Advantages of Stucco.—Stucco can be applied upon masonry walls and wooden walls in the same manner as

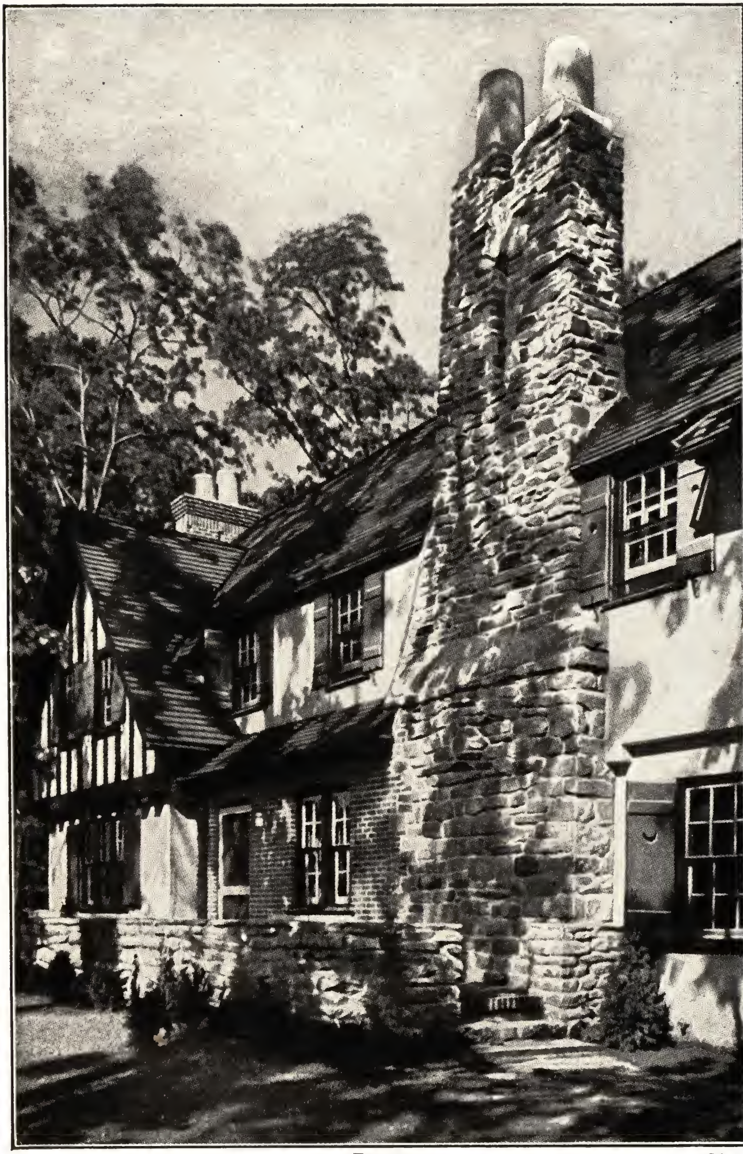


FIG 59

interior plastering. It is strong, weatherproof, and fire-resisting to a large degree. The surfaces can be treated to imitate solid stone masonry and permit the execution of architectural effects which, if obtained by the use of stone, would be very expensive. Stucco can be finished as a plain coating or in tints and surface textures as desired.

The walls of an entire building may be coated, or the stucco may be applied to portions of the wall while other parts may be of brick, stone, or wood, as shown in Fig. 59. A stucco coating can be applied to old wooden or masonry buildings, renovating the building and greatly improving its appearance.

PREPARATORY WORK FOR STUCCO

123. General Requirements.—Before any stucco is applied all roof gutters should be set, and conductors, hangers, and all other fixed supports and fasteners should be in place, so that there will be no break made in the surface of the stucco after it is once completed. All of the outside finished trim should be placed at the correct distance from the studding, or furring, to show its proper projection in relation to the finished surface of the stucco. Wall copings, balustrade rails, chimney caps, cornices, and similar work, whether made of wood, stone, or stucco, should be designed with ample drips, grooves, or lips, as at *a* in Fig. 60, or at *a* in Fig. 61, to keep water from running down on the face of the stucco.

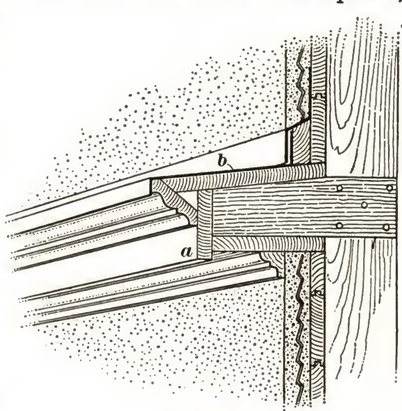


FIG. 60

124. Flashings.—Suitable flashings should be provided over all door and window openings, or wherever any projecting wood trim occurs, as at *b* in Fig. 60, and at *a* in Fig. 62, to

prevent water from entering the joints between the wood and the stucco. With copings of stone, cast cement, or brick, with mortar joints, continuous flashing should extend across the wall under the coping, and should project beyond to form an inconspicuous lip over the edge of the stucco. Similar continuous flashing should be so installed as to insure absolute protection against leakage back of the stucco.

Special attention should be given to the design of gutters and conductors at the returns of porch roofs, where it is possible that an overflow would produce unsightly discolorations of the stucco. At the intersections of sloping roof with stuccoed wall surfaces, the roof courses should first be flashed separately, and an additional strip of flashing placed over the roof flashing, extending 4 inches up on the wall surface. The stucco surface should then extend down to within 2 inches of the roof surface. Care should be taken to see that the water is in all cases led away from the stucco surfaces.

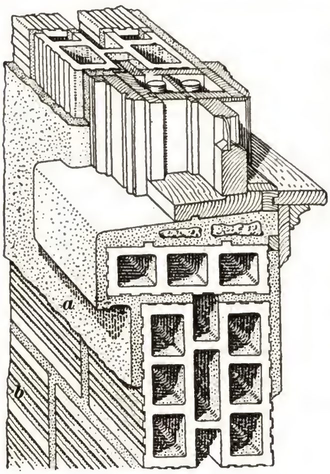


FIG. 61

125. New Masonry Surfaces.—New surfaces of stone, brick, hollow building-tile, or concrete, should have ample roughness to assure a strong bond and key between the stucco and the surface. When the walls are of brick, the joints should be not less than $\frac{1}{4}$ inch thick. The joints in new walls must be left rough, and not struck smooth. Hollow building-tile used for walls usually are scored, or grooved, to furnish a key for the stucco, as shown at *b* in Fig. 61.

126. Existing Masonry Surfaces.—When a masonry wall that is to be stuccoed has been in place for some time, as in the case of old buildings, the exposed surfaces should have all dirt, dust, or other foreign matter removed by

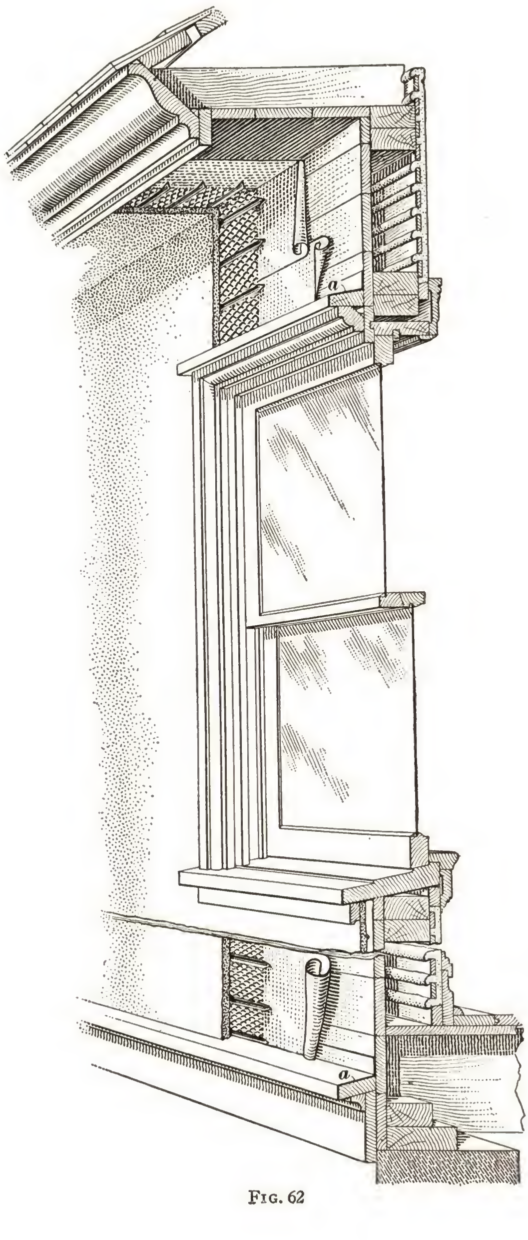


Fig. 62

means of a wire brush, or broom. All traces of moss or other vegetable growth must be removed, so as to present a clean, absorptive, surface. All loose, friable, or soft, mortar should be removed from the joints, to a depth of not less than $\frac{1}{2}$ inch. In case the surface has been painted, it will be necessary to remove the paint by means of a lye solution, or by a sharp tool which will hack away the surface. When the surface cannot be brought to such a condition that stucco will adhere firmly, furring and lathing must be applied.

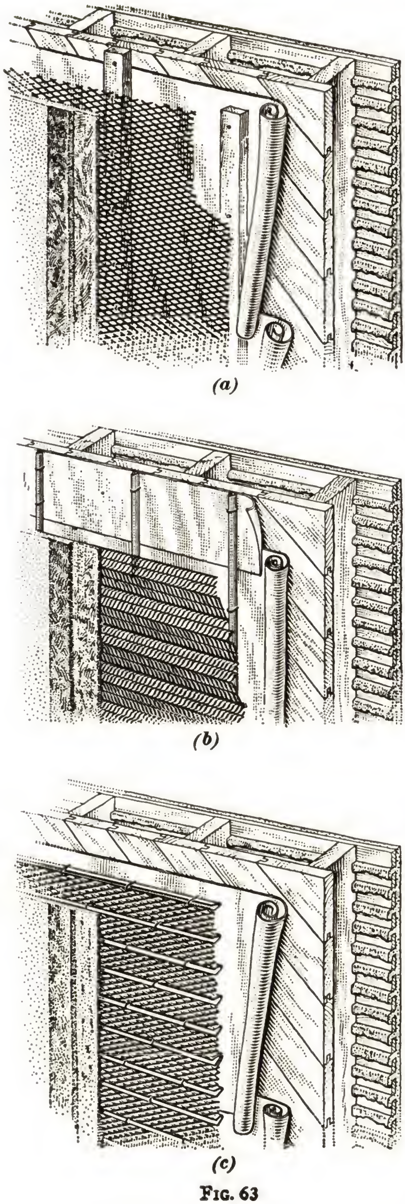
127. Furring on Masonry Walls.—When it is necessary to fur existing walls for stucco, wood or metal furring-strips should be placed vertically at 12 inch centers. Wooden plugs may be driven into the joints of the wall, to which the furring is nailed. When the furring forms part of the lath to be used, separate furring is unnecessary.

128. Sheathed Surfaces.—The frame of a wooden building should be rigidly constructed and well braced, so as to prevent cracking of the stucco from vibration, such as would occur during a violent windstorm. At least one course of horizontal bridging, or bracing, should be placed between the studs in each story height.

Sheathing boards should be not less than 6 inches nor more than 8 inches wide, dressed on both sides to a uniform thickness and nailed to each stud. Sheathing boards placed diagonally on the studding have been assumed to add greatly to the strength and rigidity of the building. Sheathing boards, however, laid horizontally across the wall studs, and fastened with at least two eight-penny nails at each stud, have been shown by tests at the United States Bureau of Standards, to produce satisfactory results with respect to the stucco itself.

129. Sheathing Paper.—Sheathing paper should be laid over the sheathing boards in horizontal layers, beginning at the bottom. Each strip should lap over the one below at least 2 inches.

130. Application of Wooden Lath Over Sheathing. When stucco is to be applied to a frame building, the studs



(a)

(b)

(c)

FIG. 63

are sheathed and papered as just described. Over the paper, furring strips should be nailed about 12 inches on centers. The furring strips are placed vertically and the lath applied horizontally as for interior plastering. The lath should be separated sufficiently to provide a good key, and the joints broken as in interior lathing. Strips of metal lath should be bent around the corners and openings, which will tend to prevent cracks that might occur at these positions.

131. Application of Metal Lath Over Sheathing.—Metal lath may be applied over sheathing in any of three ways. The first is upon wood furring placed vertically 12 inches on centers and nailed securely to the sheathing, as in Fig. 63 (*a*). The second is upon metal furring as in (*b*), applied to the sheathing with staples. A third way is to use a combined lath and furring as in (*c*). The ribs should be stapled to the sheathing so that there will be a space for a key back of the lath.

132. Plaster lath 24 by 32 inches in size is used sometimes as a stucco base. It may be applied over sheathing but usually is nailed directly to the studs. A type of lath should be used to which the stucco will adhere readily, and which will not deteriorate under the weather.

A combination of a welded steel fabric attached to a fibrous backing is also used as a stucco base. It may be applied directly to the studs or over sheathing.

MATERIALS FOR STUCCO MORTAR

133. Essential Materials.—The basic material comprising stucco may be either lime or Portland cement. What is known as lime stucco may or may not have a small amount of Portland cement added to it, and what is known as Portland cement stucco may or may not have a small amount of lime added to it. The other ingredients, in the case of either lime stucco or portland cement stucco, are fine aggregate, water, colored aggregate, mortar colors, and hair, or fiber, for the purpose of improving the quality of the stucco, or giving it a more pleasing texture or color. A variety of integral waterproofing compounds, as well as surface coatings, may be used to reduce the permeability of the stucco, and to give the desired textural or architectural appearance.

134. Portland Cement.—Any standard brand of Portland cement may be used for stucco. If a gray, or mouse-colored, stucco is desired, the ordinary gray Portland cement is used. If, however, a white stucco is desired, white Portland cements that are in the market can be used with white sand or marble dust.

If cement is used to harden lime in stucco, the amount of cement used should be about 20 per cent. of the amount of lime in weight.

135. Fine Aggregate.—Fine aggregate for stucco may consist of sand, or screenings from crushed stone or gravel. It should be well graded from fine to coarse particles, passing through, when dry, a screen having eight meshes to the linear

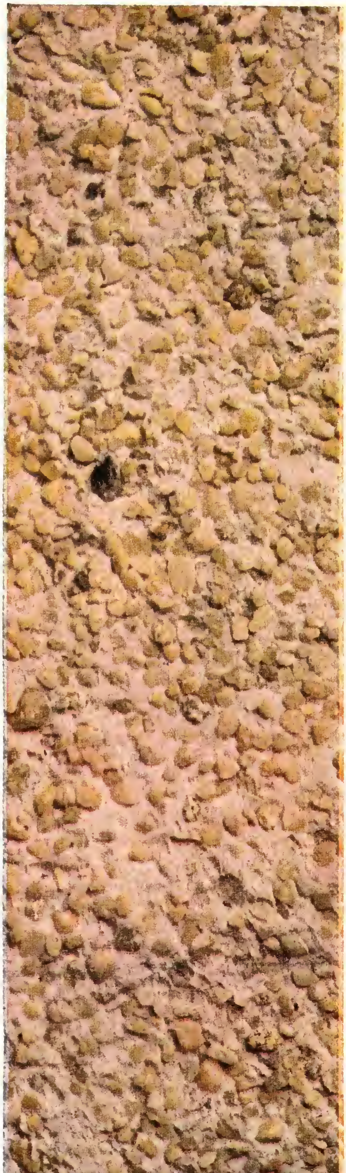


FIG. 64

FIG. 65

inch. Fine aggregate should not contain organic matter, nor more than 7 per cent., by volume, of clay or loam.

136. Water.—The water used for stucco should be clean and free from oil, acid, strong alkalis, or vegetable matter, as such substances affect the strength of the stucco, as well as the rate of setting.

137. Lime.—Freshly burned quicklime may be used for lime stucco. The lime must be slaked properly, and, preferably, should be run through a fine sieve in order to remove any unslaked particles. Hydrated lime also may be used for lime stucco, and should be used whenever a good quality of freshly burned quicklime cannot be obtained.

138. Hydrated Lime.—For the purpose of making cement stucco more waterproof, a small amount of hydrated lime may be added to Portland cement stucco. This material gives the stucco a lighter color when it is used in the finishing coat, and causes the stucco to work smoother. The volume of the hydrated lime should not exceed 20 per cent. of the volume of the Portland cement used in the mixture.

139. Colored Aggregates.—The principal materials used for giving the finishing coat of stucco a more pleasing color or texture are sand, colored pebbles, crushed granite, marble, sandstone, quartz, and gravel. These materials occur in a variety of pleasing colors, and a mixture of two or more of them is used to give a variegated appearance, as indicated in Figs. 64 and 65.

140. Mortar Colors.—Commercial preparations for coloring stucco mortar may be mixed in the finishing coat of stucco to give practically any desired color, or tone. These preparations are known as *pigments*, or *mortar colors*. As there is a possibility of reducing the quality of the stucco by the addition of too much coloring matter, the best authorities limit the amount to not more than 10 per cent. of the weight of the basis material. Only mineral colors should be used, and preference should be given to strong colors, of which

only small quantities need be used, rather than to the weaker colors, of which a larger amount is required to give the desired tone.

141. Hair or Fiber.—Hair or fiber is sometimes added to the first coat of stucco on wood or metal lath to assist in holding the stucco together until it has set. It is not necessary when the stucco is applied to masonry surfaces.

PREPARATION OF STUCCO MORTAR

142. Measuring.—The materials used for stucco mortar should be carefully measured, in order that uniform proportions may be secured. Uniformity in proportions is necessary for uniformity of quality and appearance in the finished stucco. This is particularly true when mortar colors are used for tinted effects.

A sack of Portland cement contains 94 pounds, and is assumed to occupy 1 cubic foot of space, while 1 cubic foot of hydrated lime weighs 40 pounds. The weight of a cubic foot of sand will vary from 80 to 120 pounds, according to whether it is fine, or coarse, or well graded. Lime paste is measured by the cubic foot, after being thoroughly slaked.

PROPORTIONS OF MATERIALS

143. Lime Stucco.—It is considered desirable with lime stucco to have the scratch coat the richest, and each succeeding coat leaner. An average of the quantities to use, based on hydrated lime, would be 10 cubic feet of lime to 27 cubic feet of sand for the scratch coat on masonry, 11 to 27 for the scratch coat on wood lath, and 12 to 27 for the scratch coat on metal lath. For second coats, 1 cubic foot less of lime should be used on each 27 cubic feet of sand. Where cement is to be used for accelerating the hardening, 1 cubic foot makes a good quantity to add to each of the above measurements.

144. Cement Stucco.—Each of the coats of Portland cement stucco should be mixed in the proportions of about

1 part, by volume, of Portland cement to 3 parts of sand, or fine aggregate, the exact proportion depending upon the nature of the sand, and whether two-coat, or three-coat work is being applied. It is well to increase the amount of the sand by about $\frac{1}{2}$ part for each successive coat. Hydrated lime may be added to the mixture, but not to exceed 20 per cent., by volume, of the cement. The proportions of the finishing coat will vary somewhat when special finishes are desired. When mortar colors or special waterproofing compounds are added, it is usually advisable to omit the hydrated lime.

MIXING

145. Lime Stucco.—The ingredients of the mortar should be mixed with the minimum amount of water to obtain the required consistency. When cement is added, the mixing should continue until the lime and the cement are evenly distributed, and the mass is uniform in color.

146. Cement Stucco.—The ingredients of the cement stucco should be mixed dry until a uniform color is obtained. Sufficient water should be added to produce, after thorough mixing, a mortar that is sufficiently plastic to spread evenly under the trowel, and yet be stiff enough to hold its keys on the wall or to bond to the under coats.

Mixing by machine is desirable on all work and particularly on large jobs. A batch mixer should be used, and the mixing continued for at least two minutes after all the materials, including water, are in the mixer drum. No fresh material should be introduced into the mixer until all the preceding batch has been discharged. When hand mixing is employed, the mixing should be done in a watertight box, and sufficient turnings should be given the materials, both when dry and when wet, to secure uniform color and consistency.

147. Retempering.—Mortar that has partially hardened should not be retempered, that is, remixed with additional dry materials or water. If this is done, the strength of the stucco will be greatly impaired, the color will vary from that

of the rest of the work, and the stucco is apt to be soft and porous.

No more Portland cement stucco should be mixed at one time than can be used within 1 hour after water has been added to the dry materials. With lime stucco the time may be extended, if no cement has been added. Any mortar which has begun to harden should be discarded.

APPLYING THE STUCCO

148. Spraying.—Immediately before applying the first coat of stucco, the base, if of brick or porous masonry, should be sprayed, or wet down, but not completely saturated with water. This is more necessary in hot weather than on cool, damp days. This prevents too much water from being taken away from the lime stucco, and also prevents cement stucco from setting too quickly. The masonry surface should, however, absorb a small amount of moisture from the stucco, which is the reason that the background should not be saturated.

Wood lath should be sprayed, but not thoroughly soaked, just before applying lime stucco. Before applying cement stucco the lath should be thoroughly wetted. Metal lath, stucco boards, sheathing lath, and similar preparations need no spraying before applying the stucco.

149. Names of Coats.—Stucco usually is applied in three coats on wood, or metal, lath, and in two coats on masonry backgrounds. The finish will often constitute a separate application which is not usually considered as a coat. The first is known as a *scratch coat*, or when applied to masonry, as the *rendering coat*. The second is known as the *intermediate*, or *brown coat*. In two-coat work this coat may also become the finishing coat if it is only floated and not given any of the surfaces later described. The third coat, when applied, is known as the *finishing*, or *final*, *coat*.

150. Without allowing the plaster to dry out on the edge, the application of the stucco should be carried on continuously

in one general direction. This applies particularly to the quick-setting stuccos. When it is impossible to work the full width of the wall at one time, the joint should be at some natural division of the surface, such as a door or window, at a belt course, or behind a rain conductor.

151. Scratch Coat.—The first, or scratch, coat of stucco should cover the base on which it is applied, and should be troweled well to insure a good bond with the base. On masonry walls, this coat should be sufficiently thick to fill all crevices, and cover the wall with a thickness of at least $\frac{1}{4}$ inch. On wood lath, the minimum thickness of the plaster over the lath should be $\frac{3}{8}$ inch, while on metal lath, a thickness of $\frac{1}{4}$ inch is sufficient. Before the scratch coat has set, it should be heavily cross-scratched with a saw-toothed metal comb, or other suitable device, to furnish a good mechanical key for the intermediate coat.

152. Intermediate Coat.—The intermediate, or brown, coat should be applied, in the case of lime stucco, after the first coat has thoroughly hardened, and when cement stucco is used, on the day following the application of the scratch coat. Screeds should be formed in the brown coat at 5-foot intervals to assist in bringing the surface to a true and level plane.

When the intermediate coat has sufficiently hardened, it should be floated with a wood float and firmly and evenly cross-scratched, or scored, to form a key for the finishing coat. On the following day and until the finishing coat is applied, the surface of cement stucco should be sprayed at frequent intervals, to keep it from drying out. This is not necessary with lime stucco, and is more necessary with cement stucco in warm weather than in cool weather.

153. Finishing Coat.—The third, or finishing, coat, in the case of lime stucco is applied after the intermediate coat is hard and dry; in the case of cement stucco, it is applied a week or more after the intermediate coat. This interval is necessary to allow the intermediate coat to obtain its initial shrinkage and to approach its final condition of strength and

hardness before being covered with the finishing coat. The finishing coat will vary from $\frac{1}{8}$ inch to $\frac{3}{8}$ inch in thickness, depending on the finish desired.

154. Thickness of the Stucco.—On masonry walls the total thickness of the stucco for two-coat work, should not be less than $\frac{5}{8}$ inch, and for three-coat work not less than $\frac{7}{8}$ inch. On plaster boards, the thickness should be from $\frac{7}{8}$ to 1 inch. On wood lath, the finishing coat should bring the stucco at least $\frac{3}{4}$ inch over the lath, and on metal lath, to at least 1 inch outside the furring strips which support the lath. These thicknesses are determined by the thicknesses of the grounds. A variation in the total thickness of the stucco will occur on different parts of the wall, owing to surface irregularities which are brought to true planes by screeding.

On masonry walls, and on plaster boards, the scratch coat and the intermediate coat are often applied in close succession, practically at one operation, but this is not desirable when the total thickness of the coat exceeds $\frac{1}{2}$ inch, as coats of that thickness have a tendency to bag or slip, producing an uneven and weak body for the finishing coat.

155. Drying Out.—The finishing coat should not be allowed to dry out rapidly. The surface of cement stucco, therefore, should be sprinkled frequently. Wet burlap, or similar materials, may be hung over the surface of cement stucco to keep it moist until it has set properly. Sprinkling is not necessary with lime stucco.

156. Freezing.—Neither lime nor Portland cement should be applied when the temperature is below the freezing point, or when it is apt to go below the freezing point within a few hours.

157. Back-Plastered Stucco Walls.—Stucco is sometimes applied to metal lath on studding without sheathing or papering. In this method, a coating of stucco is applied to the back of the lath as well as to the face, from which fact the method is called *back-plastering*. A section of a back-plastered wall is shown in Fig. 66. As the sheathing is

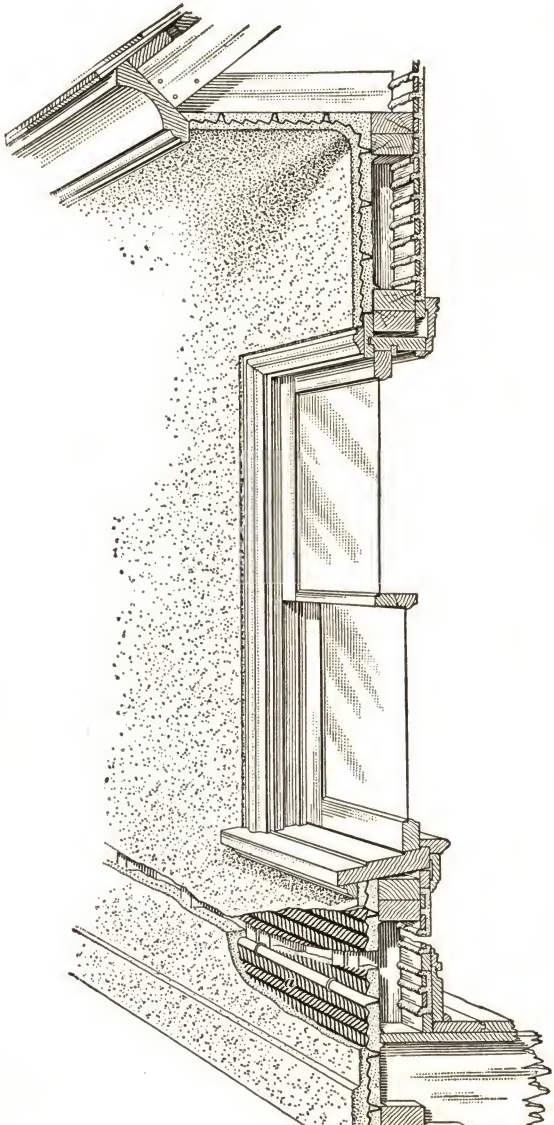


Fig. 66

omitted, the wooden framing of the structure must be particularly well braced.

158. Lathing for Back-Plastered Walls.—The lathing used for back-plastering is a combination lath and furring and the furring is applied across the studs. This assures an even thickness of plaster in front of the studs, as well as between them. Separate metal furring is sometimes used with plain metal lath stapled over it and into the wooden studs.

STUCCO FINISHES

159. The appearance of a stuccoed building depends largely on the finish of the stucco surface. Stucco finishes depend on texture and color, or on both in combination. Texture effects are due to the form of the surface, while color effects depend on the colors of the various ingredients used. As the color of the ingredients will be apparent in the various texture finishes, desired effects are generally obtained by a combination of texture and color.

Fig. 67

160. Texture Effects.—The principal surface finishes which depend on texture for their effect are *smooth-troweled*, *stippled*, *sand-floated*, *sand-sprayed*, *rough-cast*, or *spatter-dash*, and *pebble-dash*. These finishes are shown in Figs. 67 to 72, inclusive, which are made from photographs furnished by the Atlas Portland Cement Company.

161. Smooth - Troweled Finish.—In the smooth-troweled finish, Fig. 67, the finishing coat is troweled smooth with a metal trowel The surface should be rubbed as little

as possible, as continued rubbing or troweling is apt to bring an excess of cement to the surface. Excessive rubbing results also in fine hair cracks, which are readily discernible and are

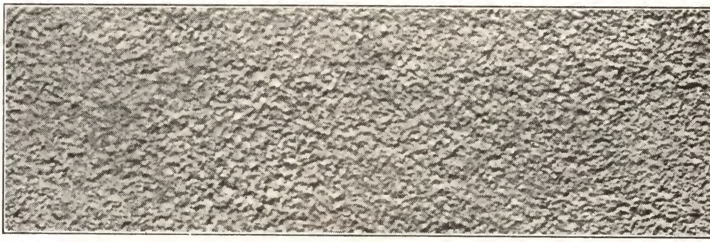


FIG. 68

objectionable in appearance. This finish is used sometimes in small panels, but is not satisfactory for large areas. In Fig. 59 are shown wall surfaces having smooth-troweled finishes.

162. Stippled Finish.—After the finishing coat has been brought to a smooth surface by troweling, it may be lightly patted with a brush of broom straw, to give an even, stippled, surface. This must be done before the cement has attained its initial set. A panel in this finish is shown in Fig. 68.

163. Sand-Floated Finish.—After the finishing coat has been brought to a smooth, even, surface, a little sand is sprinkled over the surface, and the surface rubbed with a

FIG. 69

wooden float, the float being worked with a circular motion. This floating should be done when the mortar has partially hardened. A panel with this finish is shown in Fig. 69.

164. Sand-Sprayed Finish.—When the finishing coat has been brought to an even surface, as in the smooth-troweled finish, it may be sprayed by dashing a creamy mixture of

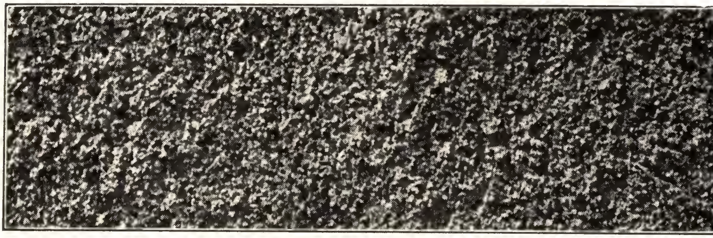


FIG. 70

equal parts of Portland cement and sand against the surface by means of a wide, long-fibered brush, similar to a whisk-broom. The coating should be thrown forcibly against the surface to be finished, and should be applied while the finishing coat is still moist, before it has obtained its early hardening, that is, within 3 to 5 hours after the application of the finishing coat. The mixture should be made up fresh every 30 minutes and kept well stirred. A panel in this finish is shown in Fig. 70.

165. Rough-Cast, or **Spatter-Dash, Finish.**—To produce the rough-cast, or spatter-dash, finish, shown in Fig. 71, the finishing coat is first brought to a smooth, even

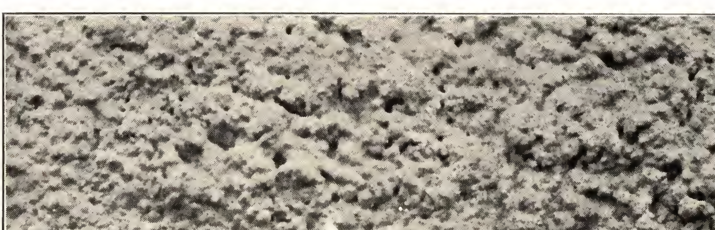


FIG. 71

surface by means of a wooden float. Before the surface has finally hardened, it is coated uniformly with a mixture in the proportions of 1 sack of Portland cement to 3 cubic feet of

sand or finely crushed stone, with enough water to make a stiff mixture. This is thrown forcibly against the surface so as to produce a rough surface that will appear to be of uniform texture. Special care must be taken with this finish to prevent too rapid drying out. To prevent this, it is necessary to wet the stucco at intervals after it has hardened sufficiently to prevent its being injured by the application of water.

166. Pebble-Dash Finish.—To produce the pebble-dash finish, shown in Fig. 72, the finishing coat is brought to a

Fig. 72

smooth surface, as in the finishes just mentioned. Before the stucco begins to harden, clean, round pebbles, or such material as may be selected, $\frac{1}{4}$ inch or larger, and previously wetted, are thrown forcibly against the wall so as to embed them in the soft mortar. The pebbles should be evenly distributed over the surface of the finishing coat, and they may be pressed back into the stucco by means of a clean, wooden trowel, but the surface should not be rubbed after the pebbles are embedded. This finish is sometimes known as the *applied-aggregate* finish.

COLOR EFFECTS

167. Color effects in stucco may be secured by a selection of the ingredients of the finishing coat of stucco, or by the application of surface coatings. Aggregates may be obtained in a great variety of colors, and these colors may be produced in the surface of the stucco by exposing the aggregates in the surface of the walls.

Ordinary lime stucco will give a pleasing whitish-gray or light-buff color, depending on the color of the sand. Stucco composed of ordinary Portland cement and common sand will have a grayish, or mouse color, different brands of cement causing a slight variation in the color of the finish. Sand occurs in various colors, such as white, yellow, red, and brown, which produce corresponding effects on the color of the stucco. Where a pure white effect is desired, it can be obtained by the use of lime, or of white cement and white sand. Hydrated lime in cement stucco will give the stucco a lighter tone. The color of the stucco may be varied further by adding pigments, or mortar colors, to the finishing coat of stucco. Should the finished surface not have the desired color, it may be coated with a wash, or paint, to obtain a more satisfactory tone.

168. Exposed-Aggregate Finish.—There are two methods of producing the exposed-aggregate finish. In the first, known as the *integral* method, the aggregate is mixed with the mortar of the finishing coat. In the second, known as the *cast-on* method, the aggregate, which may be pebbles, crushed stone, or gravel, is applied to the surface of the finishing coat in the same manner as already described for pebble-dash finish.

In the integral method, the finishing coat, consisting of Portland cement, sand, and the desired aggregate, is brought to a smooth surface by means of a wooden float. When the cement stucco has hardened sufficiently, but before it has obtained its final hardness, the surface is scrubbed with a stiff brush and water, to remove the thin film of cement which covers the aggregate. When the cement cannot be removed by this scrubbing, a solution of 1 part of hydrochloric acid in 4 parts of water may be used. After the aggregate particles are uniformly exposed by scrubbing, all traces of the acid may be removed by spraying with water from a hose.

In Fig. 64 is shown a panel in which the color effect was produced by the use of a finishing coat composed of 1 part white Portland cement, 2 parts white sand and $\frac{1}{10}$ part hydrated lime. When the surface had been made smooth,

yellow gravel was thrown on the surface and lightly pressed in. In Fig. 65, a finishing coat consisting of 1 part white Portland cement and 2 parts white sand was used, but the aggregate consisted of 1 part yellow gravel, $\frac{1}{10}$ part green marble, and $\frac{1}{10}$ part black marble.

As a great variety of materials are available for use by these methods, the architect can secure practically any surface effects. An advantage of the exposed aggregate finish is that the colors, being those of the natural stone, are reasonably sure to be permanent. The advantage, obtained in the case of colors and stones, is obtained with natural sands.

169. Pigments and Mortar Colors.—When it is desired that any of the finishes mentioned be made with colored mortar, certain mineral mortar colors, or pigments, may be added to the finishing coat of stucco. When using these materials, it is advisable to use white cement and white sand, or, otherwise, the color of the pigments would be affected by the gray of the cement and by the color of the sand.

170. Coatings on Stucco Surfaces.—Coatings for new stucco surfaces are used for the purpose of securing a suitable color, a uniform appearance, and a more impervious surface. The surface to which the coating is to be applied should be free from dust, dirt, and loose particles, in order that the coating may adhere well. The coating may consist of a thin mixture of equal parts of Portland cement and sand, to which may be added hydrated lime, or other materials to produce the desired color.

171. Coatings containing various colored pigments may be obtained for covering the finished stucco surface. After application to the surface, the liquids either evaporate or are absorbed by the stucco, leaving the pigment attached to the surface. These coatings are applied by means of a brush, or with a hose having a spray nozzle, at any time after the finishing coat has hardened. These coatings may be used to change the color of the stucco after it has been in place for a time, and as they close the pores of the stucco, they have a certain amount of waterproofing value.

WATERPROOFING OF STUCCO

172. Need and Methods.—Stucco must be impervious to moisture, which would cause disintegration through rusting of the metal lath or nails, and through the action of frost, should the stucco become saturated. Should the moisture reach the wood frame, there is a possibility of swelling as well as decay. When the moisture extends through to the interior of the wall, the dampness makes an unsanitary dwelling. A stucco wall that absorbs moisture becomes discolored and apt to show efflorescence.

173. Moisture will not readily penetrate a dense wall, and one of the best methods of making a stucco wall impervious to moisture is to grade and mix the material in such a way that the voids and pores in the stucco are reduced to a minimum. Where the nature of the materials is such that an impervious wall cannot be formed in this manner, the stucco may be waterproofed by either of two methods, one known as the *integral method*, and the other known as the *applied-coating method*.

174. Integral Method.—One method of integral waterproofing is to add 1 pound of tallow to each bushel of lime in the slaking bed before it is slaked. This is an effective integral method of waterproofing for lime stucco. The heat generated during the slaking melts the tallow. The tallow turns to soap and melts, making with the lime an insoluble material which is impervious to water. In the case of cement stucco a small percentage of hydrated lime added to mortar is an effective integral method of waterproofing. The lime, or compounds, fill the voids in the stucco, and form chemical combinations with the Portland cement, the result being that absorption of water is prevented.

Other integral methods for waterproofing for both lime and cement stucco are being offered by manufacturers, sometimes being combined as a coloring and waterproofing material, although practically colorless waterproofing may be obtained.

175. Applied Method.—In the applied coating method, the waterproofing preparations, known as exterior waterproof-

ings, brick and cement coatings, damp-proofings, etc., are applied by means of a brush to the surface of the finished stucco, two or more coats being required usually to insure good results.

MISCELLANEOUS

WHITEWASHING

176. Whitewash, a lime preparation used for coating masonry, concrete, and wood surfaces, either on exteriors, or in basements, cellars, and underground rooms, and passages, is useful for preventing decay in wood, and valuable as a sanitary material. The whitewashing often is included in the plasterers' work.

177. Common whitewash is made by slaking lump lime, and adding sufficient water to make a thin paste. By using 4 pounds of sulphate of zinc and 2 pounds of salt to each bushel of lime, the whitewash will be rendered much harder and will be prevented from cracking readily. The durability of whitewash, especially for outside work, may be increased by mixing 1 pint of linseed oil with each 2 gallons of whitewash, immediately after the lime is slaked. Whitewash may be tinted by the use of yellow ocher, Indian red, raw umber, indigo, bluing, or lampblack, the bleaching power of lime destroying most other coloring materials.

178. Whitewash may be applied to clean surfaces by means of a brush. When large surfaces are to be coated, it is economical to use a pump and hose which has a spray attachment. Rough and porous surfaces will take whitewash better than smooth and impervious surfaces. For new work, two coats should be applied, the first coat being allowed to dry before applying the second.

OVERCOATING

179. Overcoating is the process of covering the frame or exterior of an old building with stucco. The term is more generally used in connection with frame buildings, but the process is equally applicable to masonry buildings, in which case the previous directions as to stuccoing on existing masonry walls should be observed. Either lime stucco or Portland cement stucco, as already described, may be used for overcoating.

180. Advantages of Overcoating.—When the exterior of a building becomes unsatisfactory in appearance, and fails to protect the building against the elements, the process of overcoating may be employed to improve the appearance of the building, and to render it less subject to weather conditions.

181. Precautions to be Observed.—Before commencing the overcoating, the building should be carefully inspected to determine whether it is in satisfactory shape to receive the work, and whether the expense will be justified. The frame of the building must be sound, the doors and windows made true, and the walls plumbed, before the work proceeds. While this is not the work of the plasterer, he must see that it is all in proper condition before he can hope to do satisfactory work.

182. Particular attention should be paid to the roof and to the drainage system. A tight roof is essential, and such repairing must be done as will insure against any leakage that might get in back of the finished stucco. Especial attention must be paid to the details of flashings and drips. A careful design of the building at these points will prevent discolorations and disintegration due to water finding its way back of the stucco.

183. Masonry Buildings.—Stucco can be applied directly to the surface of masonry walls, provided that thorough cleanliness, a good mechanical bond, and proper absorption may be obtained. It is most important that masonry walls be clean before the stucco is applied. When the masonry surface can-

not be brought to the condition of a base that will hold the stucco firmly, the surface should be furred out and lathed as is done for new work.

184. Frame Buildings.—When frame buildings are to be overcoated, they should be made structurally sound in every respect. If the old siding is in poor condition, so that the furring and lath cannot be held firmly, the siding should be removed, the walls covered with waterproof paper, and then furred and lathed, in the same manner as described for new work.

When it is necessary to remove the sheathing as well as the siding, the studs should be braced, and furring and lathing applied as described for back-plastered walls.

185. Where overcoating is to be done over beveled siding, flush, or novelty siding, clapboards, or shingles, the furring and lathing will cause the face of the stucco to be some dis-

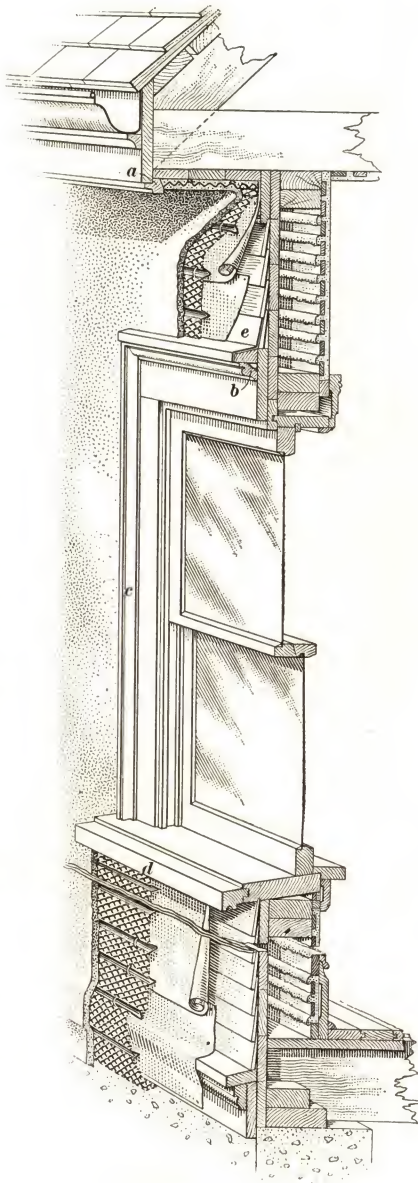


Fig. 73

tance out from the original surface, usually so far that the cornice, sills, and trim, will not show properly. It will be necessary to fur out for the new positions of cornice members, and to reinforce the outside edge of window sills to conform to the new outside surface of the walls. A face molding of suitable size will be required around the edges of window, and door, casings, and other trim must be built out as required. All the trim should be placed in such a manner that it will show its proper projection in relation to the finished stucco surface.

A typical method of adapting overcoating to a building having beveled siding is shown in Fig. 73. A new molding is placed at *a*, against which the stucco finishes. The trim of the window is built out by means of a new cap *b*, the lower molding of which extends down the jambs at *c*, to an extension sill *d*. The backs of moldings *a* and *c* are beveled, so as to cover the joint between the molding and the stucco, and to hold the stucco firmly in place. Flashing *e* is built in over the head of the window to prevent any water from getting back of the woodwork at that point. Ribbed furring lath is then placed on the siding, or furring may be used to support plain lath.

Ordinary wood lath is sometimes used for furring, but it is not as desirable as furring $\frac{5}{8}$ inch thick, as there is less space for plaster behind the lath.

It is always desirable, when over coating over sheathing or siding, to cover the surface with waterproof paper before applying the furring, as this will keep the moisture of the stucco from being absorbed by the siding. It will also make a warmer house in winter.

ARCHITECTURAL TERRA COTTA

Serial 5270 Edition 1

ADVANTAGES, USES, AND DESIGN

INTRODUCTION

1. Terra cotta such as is used for trimming or facing walls of buildings, forming ashlar facing, cornices, columns, sills, and lintels over openings, etc., is technically known as *architectural terra cotta* to distinguish it from the form known as *structural terra cotta,* which is used in the construction of walls, partitions, floor arches, and enclosures for steel columns in fireproof buildings.

2. All terra cotta is made of clay, which is ground with water in a mill, molded into shape, and then placed in a kiln and burned to a bricklike consistency. Architectural terra cotta is made of a better grade of clay than structural terra cotta and is so treated as to form a plastic mass that can be molded into forms of very intricate pattern. Great care is required in forming and handling the blocks, in finishing the surfaces, and in

burning, to secure a product that will be free from defects and suitable for the purpose intended.

3. Terra cotta is extensively used for trimming or facings for exterior and interior walls of buildings, and for such purposes it is a durable, beautiful, and economical material.

Properly made terra cotta is fire-resistant, frost-proof, and weather-proof, in which characteristics it is superior to stone. It lends itself to a great variety of color effects and can be molded or ornamented with comparative ease to produce either plain or intricately ornamented work that will stand the wear and tear of centuries.

From the structural standpoint, terra cotta is a most desirable material to use on account of its durability and adaptability to many kinds of structures. It is equally adaptable to a building having masonry walls or one having a framework of steel or of reinforced concrete.

ADVANTAGES AND USES OF TERRA COTTA

4. Facings for Walls.—Terra cotta, when used as a facing for masonry walls, may be bedded in mortar and built into the wall in the same manner as stone or brick.

As a facing for a steel-frame or reinforced-concrete-frame-structure, terra cotta is a desirable material, as the blocks may be designed and formed to fit the shape of the structural parts that support them. The blocks may be kept away from these parts a distance of from one to two inches to allow for irregularities in the structure, thus avoiding expensive cutting and fitting such as is often required when stone is used. In the forms of structures mentioned the terra cotta is usually attached to the supports by means of metal anchors, and the space back of the blocks is filled with masonry.

5. An advantage that terra cotta has, when used as a facing for a reinforced-concrete building, is that the entire rough concrete structure can be built and completed on the inside before the terra cotta is applied. The terra cotta does not require to be bonded with the wall, piece by piece, as the wall progresses, but may be put in place afterwards and secured to

the wall by means of metal anchors that have been previously built into the wall. By this method, the terra cotta may be in the making at the factory while the building is being erected.

6. In addition to the employment of terra cotta for building fronts and for interior work, there is considerable demand for its use in cornices and balustrades to take the place of more expensive cut stone, copper, or perishable sheet metal, such as tin or galvanized iron.

7. Fire-Resisting Qualities.—Terra cotta is a good fire-resisting material, as it can stand the heat of a conflagration better than stone. It can therefore be used in office buildings and other structures where it is necessary to cover a steel frame with a material that will conceal and protect the steel and at the same time give a pleasing and permanent architectural finish to the structure.

8. For Ornamental Work.—Terra cotta as a material for ornamental work in buildings has several advantages over cut stone which make it especially desirable to use under some circumstances. One of these is that the sculptor who models any ornamental part of a building in terra cotta can be sure that his model will be accurately reproduced, because the process of casting terra cotta is a mechanical one by which the original model made by the sculptor is exactly copied in the plaster mold and reproduced in the clay when pressed into the mold. When stone is used, the sculptor makes a clay model from which a plaster cast is taken and this is copied by the stone carvers with more or less fidelity, according to their proficiency and the accuracy with which they can interpret the sculptor's original model. As a rule, sculptors themselves do not carve the stonework but are dependent for the excellence of the results upon the skill of the stone cutters employed by them.

9. Another advantage is that terra cotta can be glazed with any color desired, so that great variety in tint can be obtained; thus it is not dependent upon its natural color, like stonework, nor upon the color produced by the burning, as is the case with brickwork. The ability to glaze terra cotta with

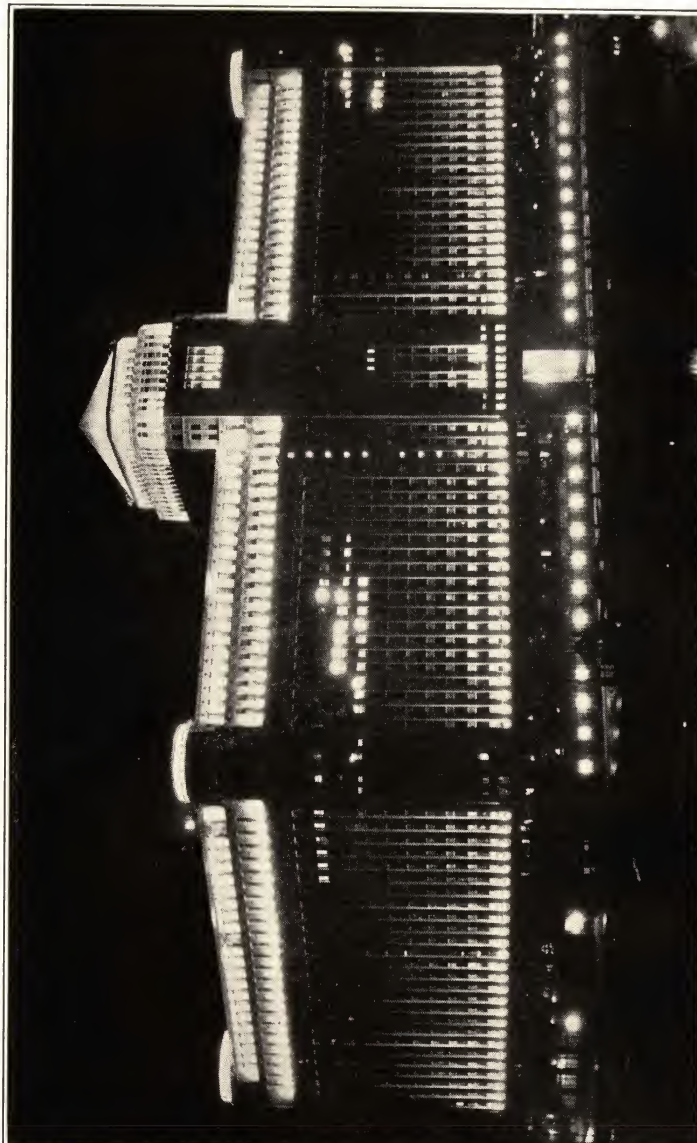


Fig. 1

colors opens up a wide range of possibilities for the designer who appreciates the effectiveness of color in his designs. Color in terra cotta is not affected by time or weather. Though dimmed by dust or smoke, the material may be quickly restored to its original color by washing. Colored glazed terra cotta is called Faience or *polychrome* terra cotta, *polychrome* meaning many colored.

White, full-glazed terra cotta is especially useful for the fronts of buildings, for lining light-courts, or wherever it is desirable to reflect the light as much as possible.

10. Weather-Resisting Qualities.—As a weather-resisting material, architectural terra cotta is very superior. When properly glazed it is non-absorbent and is thus excellent for structures built in large towns and cities where smoke and dust are always in the atmosphere. Terra cotta can be so glazed that it is impervious to water, and buildings faced with it can be washed down whenever desired, and made to look as fresh as when new.

11. Lightness in Weight.—For special purposes where a saving in weight is necessary, terra cotta is especially useful, as in a dome where it is required that the structure shall be light in weight and at the same time durable and weather resisting.

12. Economy.—Terra cotta also has an advantage in economy, as it generally costs somewhat less than stone, and being lighter in weight requires less steel to support it.

Terra cotta members having richness of detail, such as flutings, ornamental panels, belt-courses, elaborately modeled column capitals, or similar members, can be produced in duplicate at much less expense than in cut stone, each unit of which must be laboriously carved by hand. Even in the plain members that are often used as a facing, the blocks may be formed of practically one size and by the use of very few molds may be cast in great numbers, whereas in stone facings each piece requires to be cut and finished as a separate unit.

13. Floodlighting.—Terra cotta lends itself to the use of floodlighting, or special illumination at night. Glazed terra

cotta, in particular, is preeminent as a reflector of light, especially when the floodlighting is designed to set off its advantages.

The reflecting surface of glazed terra cotta is such that it may be illuminated at much less expense than is required for most other building materials.

In Fig. 1 is shown an illustration of the interesting effects that may be obtained by floodlighting a portion of a building that is faced with terra cotta. The building shown in this illustration is the Merchandise Mart, in Chicago, designed by Graham, Anderson, Probst, and White, Architects.

14. Coloring.—One advantage can be obtained in terra cotta that it is almost impossible to obtain in any other single material. In these days color is playing an increasingly important rôle in the decoration of buildings both on the exterior and in the interior, and terra cotta provides an opportunity for the use of the entire range of colors together with glossy and mat surfaces. Rich modeling rendered in colors is easily produced in this material.

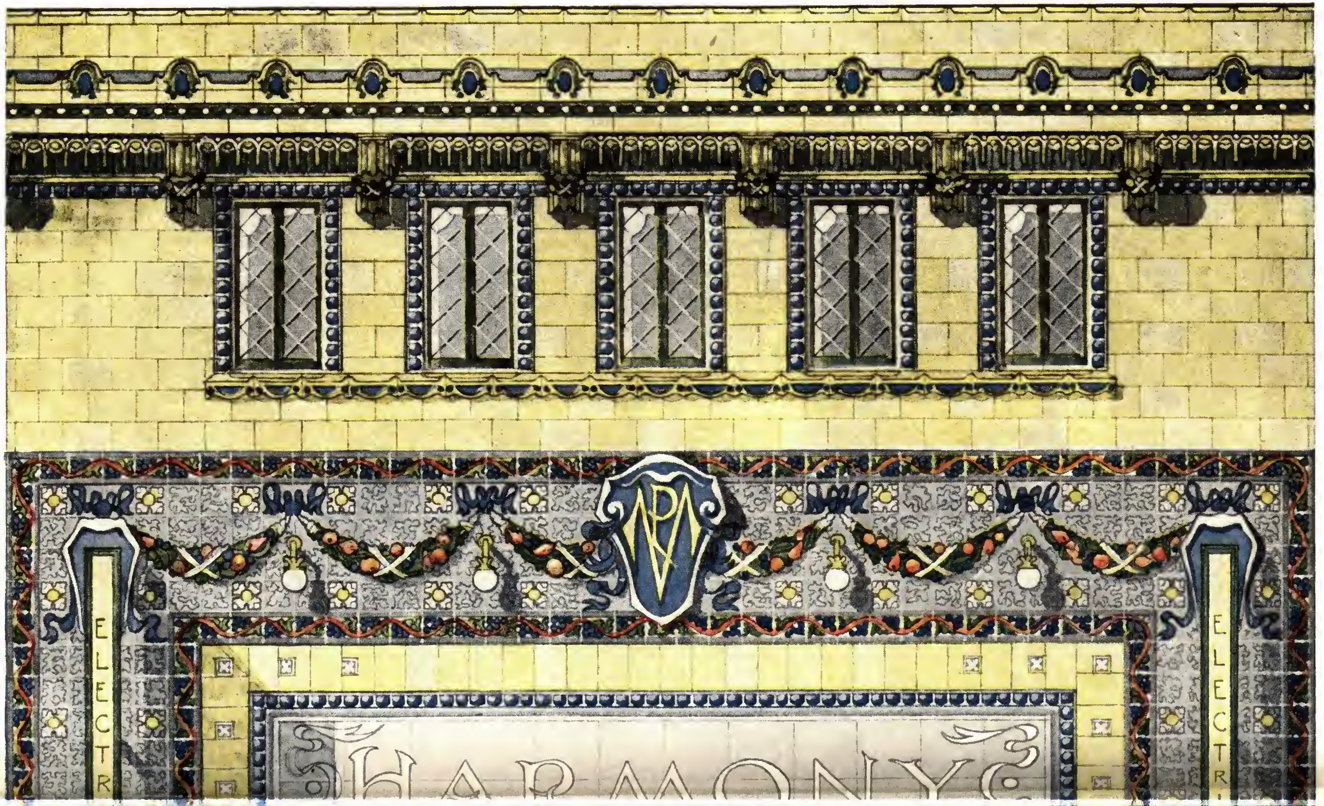
Color, however, is related to form and, when rich and varied colors are wanted, it is desirable to simplify the forms to which the color is applied. Color and form should not be made elaborate in the same piece of work, as one will confuse and spoil the effect of the other. As color is emphasized, form should be subordinated and *vice versa.*

By applying slips and glazes to the surfaces of the modeled blocks a great variety of colors can be obtained. When the blocks are burned the colors and surfaces become hard and practically imperishable, making the blocks impervious to the weather and very durable.

An example of a theater façade in which colored terra cotta has been used is shown in Fig. 2.

DESIGN OF TERRA COTTA

15. In designing buildings in which architectural terra cotta is to be used, the architect should have a good knowledge of the nature of terra cotta, as well as of some of the peculiar conditions that govern its manufacture. Architectural terra


HARMONY

Courtesy of the National Terra Cotta Society

FIG. 2

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cotta should be designed in accordance with the characteristics of the material itself even when it is used to resemble some other material, such as cut stone.

CHARACTERISTICS AFFECTING DESIGN

16. The characteristics of terra cotta that affect its use and design are, first, that terra cotta is a burnt product that shrinks and warps somewhat in burning. This characteristic makes it difficult to use large pieces of terra cotta in plain-surface work, as irregularities in the surface will not look well in the front of a building. This defect is largely overcome by using the terra cotta in medium-sized blocks so that the deformities will be small and practically negligible.

A second characteristic is that the clay of which the terra cotta is made lends itself readily to modeling or ornamentation. The use of modeling or ornament over the surfaces of terra-cotta work serves to conceal deficiencies due to warping and shrinking, and terra cotta work containing considerable ornamentation always looks better than plain work. This modeling can be done quite easily and, after a mold has been made for a piece of ornament, a great number of similar pieces can be cast in the same mold. Hence, the oftener an ornament is repeated on a surface the less will be the relative cost of the terra cotta per piece, as the repetition of the same pattern will be much cheaper than the use of a number of different patterns.

A third characteristic is that very elaborate, bold, and projecting ornament for special positions can be easily made in terra cotta. The modeler makes the desired form in clay and the model is cut up into suitable-sized pieces, dried, glazed, and baked.

A fourth characteristic of terra cotta is that it can be colored in any desired tints and thus a field for design in color is opened to the designer.

A fifth feature is that it can be finished so as to resemble other materials, especially cut stone such as granite.

Thus terra cotta lends itself readily to ornamental treatment either of a bold or a delicate nature, to elaborate or delicate color effects, and to texture design.

Fig. 5

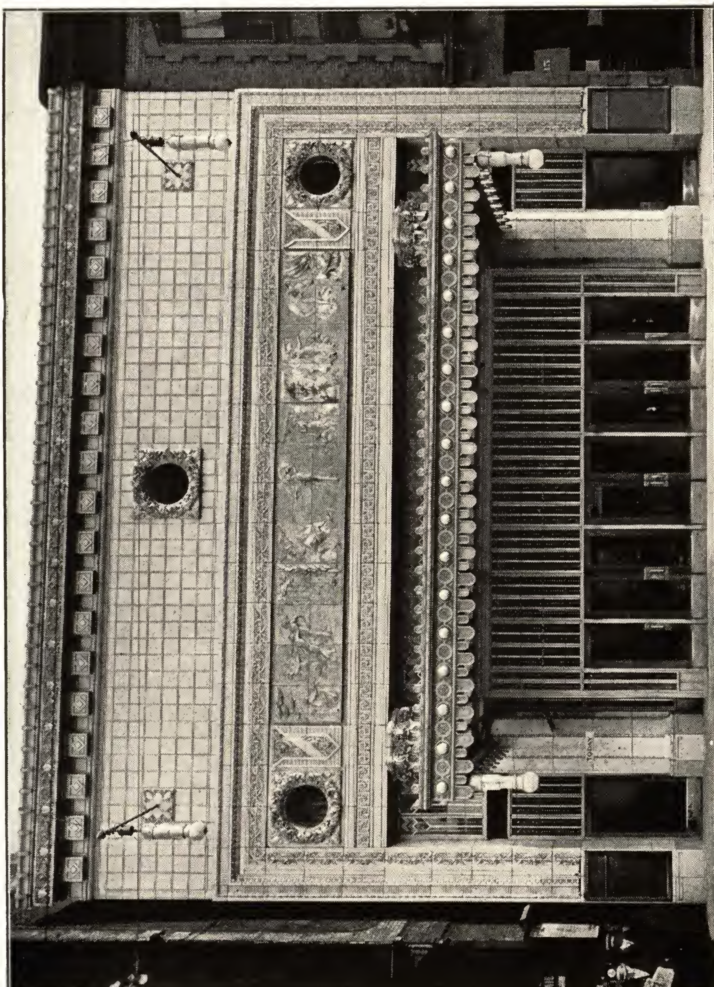


Fig. 4

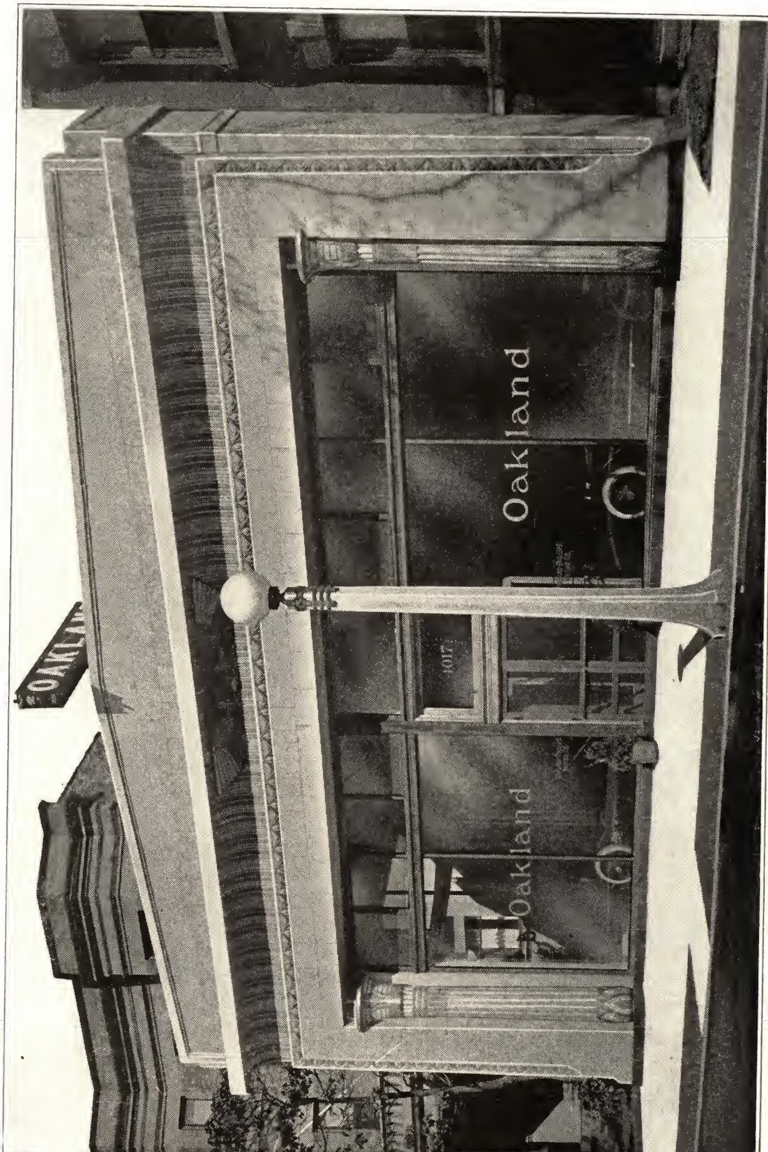


Fig. 5

PLAIN SURFACES

17. Good examples of plain surfaces formed of architectural terra cotta are shown in Figs. 3, 4, and 5. In Fig. 3 fancy jointing of the flat surface has been effectively used.

Here it is possible to use considerable ornament and still keep the cost within limits, as the ornamentation includes repetition of similar motives that are easily reproduced in terra cotta. Had stone been used the cost would have been prohibitive. In Fig. 4, the use of small units with beveled joints results in an interesting surface. The use of small units is also illustrated in Fig. 2. In Fig. 5 the plain ashlar surfaces, where small units have been used, have the effect of the finest stone work. This building shows an unusual and interesting use of the ancient Egyptian style of Architecture.

MODELING TERRA COTTA

18. Figs. 2, 3, and 4 not only show a proper treatment of terra cotta in plain blocks but illustrate the superior appearance of terra cotta when richly decorated. It will be noted that there is a considerable repetition of blocks of the same pattern, which would be extremely costly if worked in stone. These examples illustrate the possibilities of ornamentation in terra cotta work in several ways. Shallow modeling, or *low relief* work, is shown in borders and band courses. Bold modeling, or *high relief*, is illustrated in the wreaths around the circular windows and in the capitals of the polygonal piers in Fig. 4. An excellent illustration of figure modeling is shown in the panel of dancing figures above the main entrance. The buildings shown in Figs. 2, 3, and 4 are very good examples of the intelligent use of terra cotta.

19. Repetition of Ornament.—It is economical in the use of any plastic material, such as clay, to use the same ornament or motif repeatedly in the design, as this tends not only toward harmony of design, which might be too complicated otherwise, but also toward economy in manufacture. As every piece of terra cotta employed in a building must be formed in a mold,

FIG. 6

the fewer molds that are required the less will be the cost of the work. As the number of pieces needed in even a small structure often runs into the hundreds, and on larger buildings into the thousands, it can be readily seen that a large number of molds greatly increases the expense of manufacture. By repeating patterns, the same plaster mold can be used to cast from 25 to 40 blocks of the same design, which greatly reduces the cost of manufacture.

Designers should, therefore, see to it that they make their designs economical by using a repetition of patterns as much as possible. Thus, a simple running cornice in which each block is like its neighbor on either side, is less expensive to produce than a cornice composed of blocks of several different patterns.

Lintels and sills for windows, if all of the same pattern, can be produced with a minimum number of molds, but if the lintels on each story vary, or if the several parts of each lintel are different, the number of molds required will be very large.

20. Modeling in High Relief.—Terra cotta can be modeled in high relief; that is, the ornament can be made so as to project boldly, as shown in the modeling of the eagles in Fig. 6. The heads of the figures above the lower eagle are also in high relief, but low relief is shown in the draperies and accessories.

Terra cotta usd in full relief is again shown in the groups of statuary, and low relief in the figures on the octagonal buttresses. This example shows an interesting variety of modeled and sculptured forms.

The ornaments over the cornice and the large consoles or brackets in Fig. 7 are also examples of modeling in full or high relief.

21. Limitations in Size of Blocks.—Stone can be used in large units, its size being determined only by the practicable size in which it can be quarried, worked in machines, shipped, and erected in place. Thus even huge columns of stone may be *monolithic,* or of a single piece of stone. Terra cotta, however, cannot economically be molded in very large units. There are several reasons for this. When undergoing the drying operation in the dry room, shrinkage in large pieces would be

Fig. 7

so much more than it is in small units that the blocks would tend to warp and crack. After drying, uniform burning in the kilns becomes very much more difficult with large blocks than with small ones and the warping is greatly increased because the heat does not attack all surfaces evenly. The handling and shipping of large blocks requires much more care than when smaller units are employed and there is much more waste from broken blocks. Hence the cost is greatly increased. It is not economical to use blocks greater in size than 27 in. $\times$ 24 in. $\times$ 36 in. Blocks, especially thin facing or veneering blocks, are made much smaller than this size, as the smaller blocks are usually more economical to manufacture.

COLORING TERRA COTTA

22. Some of the most interesting designs in modern terra cotta are in colors, such as blues, greens, yellows, browns, and reds. Polychrome terra cotta in such designs is largely used for churches, office buildings, store fronts, theaters, and interior decorations; in fact, wherever the design itself is susceptible to the proper use of color. Usually the background of terra cotta is kept in one tone and the modeled portions of the design are in variegated colors. Hence, the latter stand out from the background, and many rich and beautiful effects are obtained.

In Fig. 2 is shown a good example of the use of polychrome terra cotta. In this case it is used for a theater front. The one-tone background consists of plain-surfaced pieces in a cream color and the modeled portions are in blue, green, and brown. The large panel immediately over the entrance to the building is also formed of plain pieces, in a gray color. This panel is intended for an advertising sign which may be applied to its surface.

DESIGNING TO RESEMBLE OTHER MATERIALS

23. Architectural terra cotta is frequently designed to resemble other materials, such as stones of different kinds, and with various finishes. Granite, with its mottled or speckled-coloring, limestone and sandstone with the various toolings of the surfaces, can be closely copied. The cost of the terra cotta

is generally less than the cost of the stone. Terra cotta is frequently used in conjunction with stone on the same building, the walls and plain surfaces being finished in the stone, and the ornamental parts, such as cornices and the more richly decorated portions, being formed of terra cotta. When new, the difference in the materials can hardly be distinguished, but after a time the effect of the weather often causes a decided difference in the appearance.

24. Terra cotta that is designed to resemble some other material, such as granite or Bedford limestone, should have the forms of the blocks and the joints as like as possible to those generally employed for the material it is to be like, otherwise the effect it is desired to obtain may be lost.

To follow out this idea, quoins and rustications are sometimes used, arches with keystones may be employed over openings, and often pilasters and panels are used. In a façade intended to resemble cut stonework the greater number of vertical joints required by terra cotta, because of the small size of the blocks, tends to spoil the effect, but a little careful planning will make it possible to put many of the vertical joints in angles where they will not be noticeable.

25. The building entrance shown in Fig. 7 is made of terra cotta formed to resemble granite. This entrance is designed with both plain and ornamented parts. The lower members adjoining the doorway, which in the illustration show darker than in the remaining portions, are finished with a glossy surface called *full glaze* and the other portions are finished with a less glossy surface called *mat glaze*. These terms are defined more fully later in this Section. It will be noted in this illustration that the blocks of the upper part of the doorway are small in size, as indicated by the numerous joints, while no joints are visible in the lower members. This is due to the lower members being made in long narrow pieces and the joints being formed vertically in the design, where they are not noticeable. This gives this lower part the appearance of being formed of large pieces of granite, which adds very much to the attractiveness of the design.

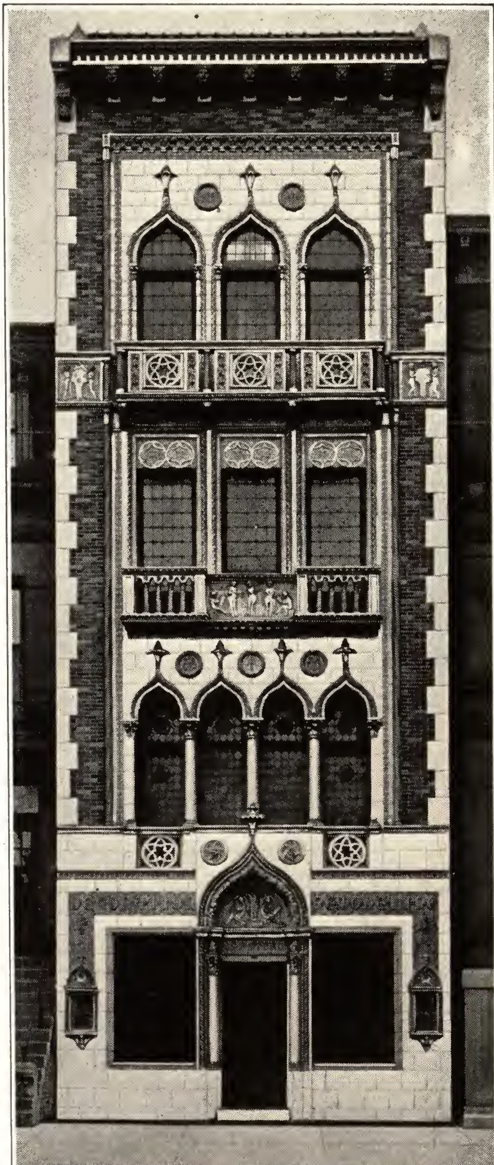


Fig. 8

Fig. 9

26. Figs. 8, 9, 10, and 11 all show the use of terra cotta in the construction and decoration of buildings of different types. In Fig. 8 is shown a beautiful façade that was evidently inspired by the Gothic palaces of Venice. The ornamentation, formed of terra cotta, is rich and varied and illustrates the great variety and beauty of detail that can be obtained in terra cotta.

In Fig. 9 is shown a handsome country residence in which terra cotta is used in place of stone for all the trimmings. The terra cotta is treated in a more ornamental manner than stone would be. The similarity of design in many of the parts is evident in the panels under the windows, over the entrance projection and over the porch. The square panels above the windows over the porch and over the entrance are of two patterns and are cast from two molds. The short pilasters around the top of the wall above the porch and the entrance are all of the same pattern and made with one mold. Thus a very elaborate ornamentation is obtained by the use of three molds from which a great number of similar pieces have been made.

27. A moving picture theater building is shown in Fig. 10. Here the fanciful design and ornamentation is freely used, and repeated ornaments of various kinds are employed. Elaborate ornament such as is displayed in this façade can be produced advantageously in terra cotta.

28. The building shown in Fig. 11 is a service station the walls of which are faced with terra cotta designed like stonework. A very substantial and artistic effect has been produced.

29. In all of these figures is shown the repeated use of similarly formed blocks both for plain and ornamented parts. Were the material stone, the ornamental parts of the design in many cases would not be attainable on account of the excessive cost in executing the designs in this material.

STOCK DESIGNS

30. Most of the terra cotta used for buildings is especially designed by the architect and is made to order. As the process of manufacture requires from six to eight weeks after the approval of the drawings and details, the architect often finds

it desirable to use stock designs that can be obtained quickly and which often suffice for small structures. Most manufacturers

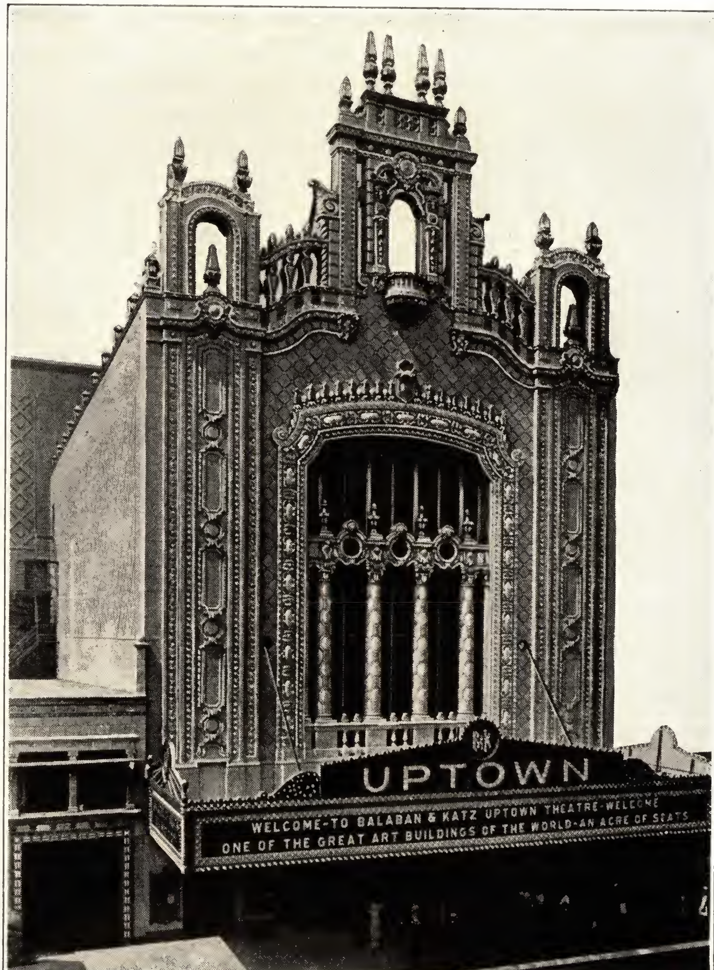


FIG. 10

keep a stock of molds for certain designs. The use of these stock molds reduces the cost of manufacture materially and also shortens the time required to make the terra cotta.

The designs that the manufacturers keep in stock necessarily consist of the more ordinary forms, for no manufacturer could afford to manufacture and carry a very extensive variety of patterns not knowing what the market demand might be.

For use in brick buildings, manufacturers also carry a line of stock designs for terra cotta inserts, such as small ornamental blocks and small panels that can be readily inserted in face brickwork to produce an ornamental design.

Architects who contemplate using stock designs of terra cotta can obtain catalogs from manufacturers showing what patterns they carry in stock and giving the colors, finishes, and dimensions. The building in which it is proposed to use such patterns must, of course, be designed to fit the stock form of blocks, for the blocks cannot be cut and must be used in the size and shape in which they are manufactured.

An illustration of the use of stock patterns of terra cotta for a building front is shown in Fig. 3. The members which form each ornamental band or belt-course, also the panels of the pilasters, are small units of the same design, and plain pieces of terra cotta are used in various sizes to secure the required spaces for the ornamental parts. The coping is formed of both plain and ornamented pieces and is raised at intervals by means of special pieces to suit the requirements of the large ornaments that are placed over the second-story windows.

The panels over the first-story entrances, which contain the lettering, require to be made to order.

STRENGTH AND WEIGHT OF TERRA COTTA

31. Well-burned terra cotta will stand a compression test of 5,000 pounds per square inch, which is ample for any loads that are likely to be placed upon it.

The weight of hollow terra cotta blocks, unfilled, is from 65 to 85 pounds per cubic foot. When filled with brick they weigh from 120 to 130 pounds per cubic foot, and when filled with concrete, from 130 to 140 pounds.

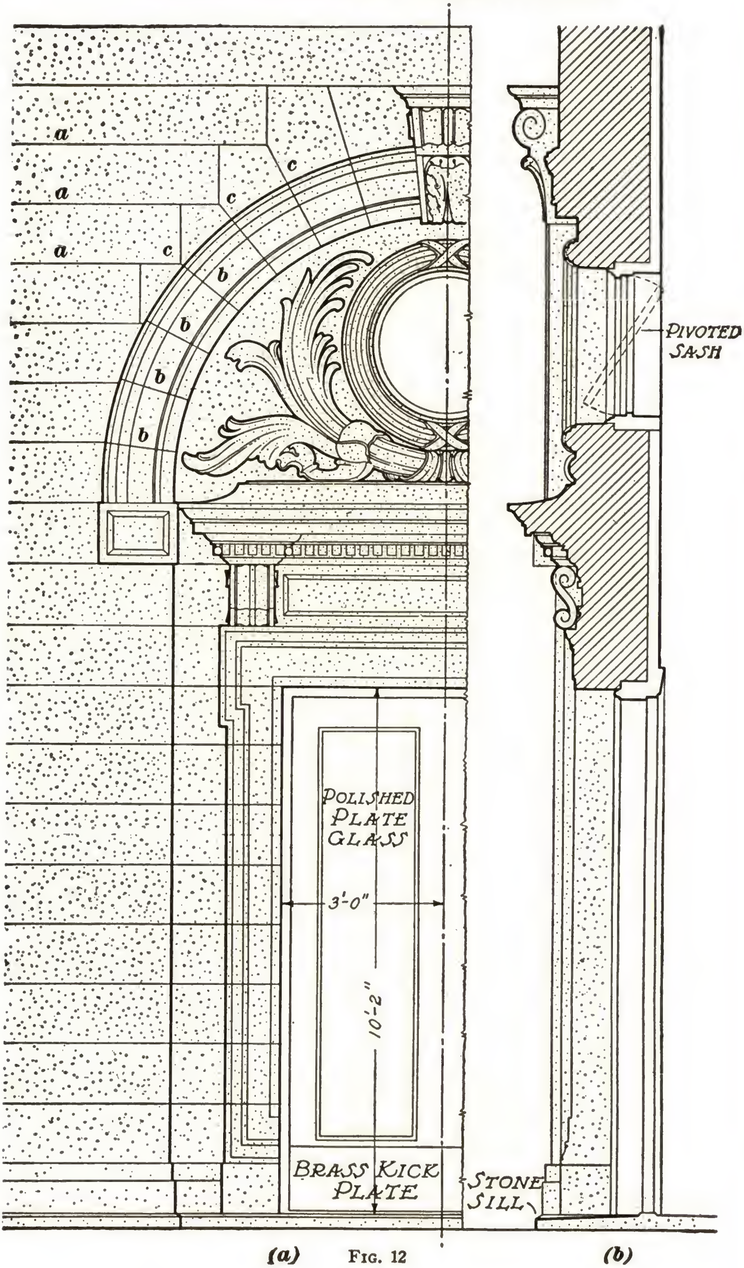
Fig. 11

ARCHITECT'S DRAWINGS

32. The architect's original working drawings usually consist of plans, elevations, and sections, drawn to a scale of $\frac{1}{4}$ inch or $\frac{1}{8}$ inch to the foot. These should clearly indicate the various materials that are to be used and the general form of construction. If terra cotta is to be used, the drawings should show the parts that are intended to be plain, those that are to be ornamented, and the general supports on which the terra cotta is to rest. These drawings will be sufficient for the manufacturer to bid from.

After the contract for the terra cotta has been awarded, the architect should prepare large-scale drawings that will show fully the forms of the terra cotta parts and will give suggestions as to the jointing. He may if he desires prepare full-size details that will show the contour of all moldings, as well as the nature of the ornamental parts. These drawings are then given to the manufacturer to follow when making his shop drawings. It is customary, however, for the architect to require the terra cotta manufacturer to make the full sizes in which case they are drawn to shrinkage scale.

33. Example of an Architect's Drawing.—An example of an architect's drawing for an entrance and wall finished in terra cotta is shown in Fig. 12. Such a drawing is generally made to a scale of $\frac{3}{4}$ inch = 1 foot. An elevation of part of the entrance is shown in (*a*) and a section through the entrance in (*b*). At *a* in (*a*) are shown the architect's suggestions for the horizontal jointing of the wall blocks; at *b*, the jointing for the arch over the entrance; and at *c*, the jointing for the terra cotta in the wall where it intersects with the arch. The jointing of the ornamental panel over the entrance is not shown in this drawing, as it is left to the manufacturer to determine what forms of blocks he can cast that will conceal the joints as much as possible.


a
a
a
c
c
c
b
b
b
b
POLISHED
PLATE
GLASS
3'-0"
10'-2"
BRASS KICK
PLATE
STONE
SILL
PIVOTED
SASH

(a) FIG. 12 (b)

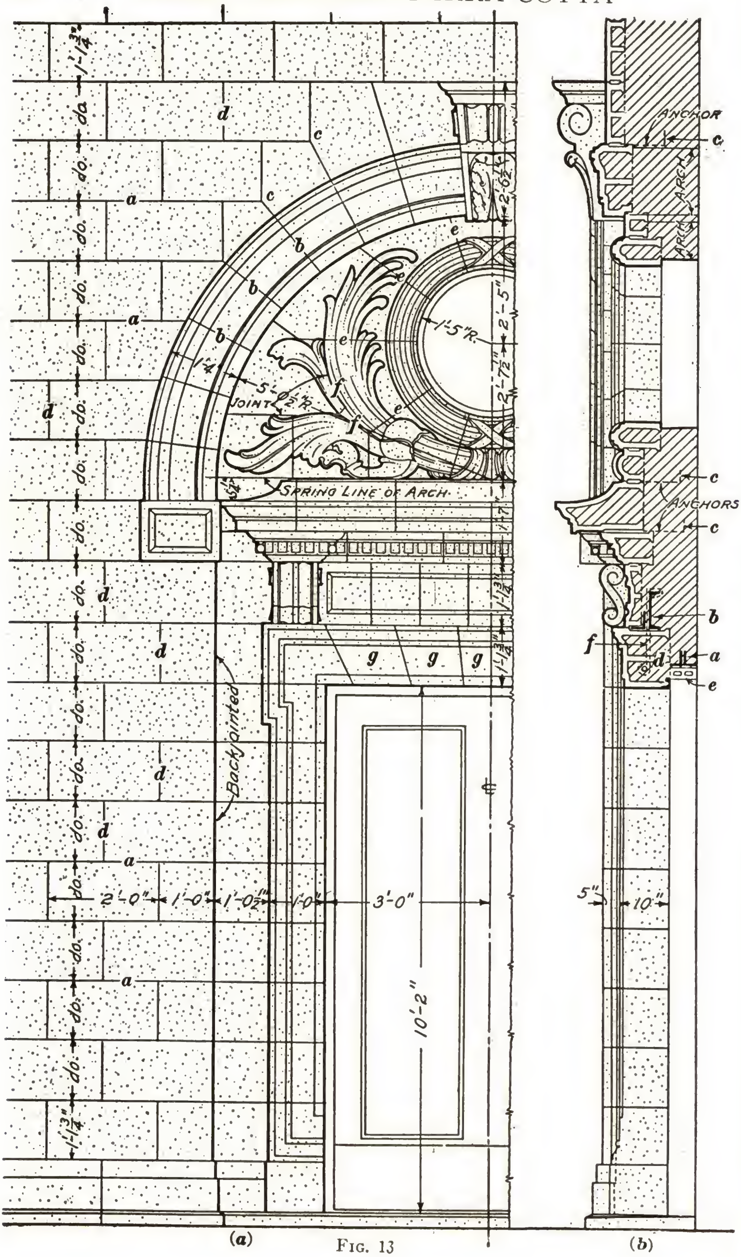
MANUFACTURER'S DRAWINGS

34. The architect's drawings are sent to the manufacturer of the terra cotta, who copies them and adds details of jointing and of anchoring the blocks to the constructional parts of the building. These drawings are then submitted to the architect for approval. The architect makes any changes and corrections on them that his judgment may dictate, marks them *Approved,* and returns them to the manufacturer. The manufacturer then proceeds to make further detail drawings which are drawn to what is called the *shrinkage scale* as will be described presently.

35. Example of a Manufacturer's Drawing.—In Fig. 13 is shown the manufacturer's drawing of the same entrance that was shown in Fig. 12. It will be noted that the horizontal joints *a* of the plain wall, the radiating joints *b* of the arch, and the joints *c* between the wall and the arch, as shown in Fig. 12 (*a*), have been retained. Vertical joints *d*, Fig. 12 (*a*), however, have been added to show the length of the wall blocks. The joints *e* and *f* are suggested for the ornament over the entrance. These joints are made to follow the form of the ornament as far as possible so that they may be partly concealed.

In Fig. 13 (*b*) is shown the contour of the terra cotta blocks that occur in this section, the depths that these blocks set into the wall, and the manner in which they are secured or supported. All of the terra cotta over the doorway, also the masonry with which it is backed up, is supported by the steel members shown at *a* and *b*. Anchors *c* are used to tie the projecting blocks to the body of the wall. The blocks *d* are designed to form a self-sustaining arch, as shown at *g* in (*a*). To prevent any settlement of these blocks or the opening of the joints between them, they are usually anchored to the steel members by means of small suspension rods, shown at *f* in (*b*). The blocks *e* in (*b*) are likewise suspended from the steel member *a*. The diagonal lines show the backing which consists of brickwork.

36. Shrinkage of Terra Cotta.—Since terra cotta shrinks in manufacture about $\frac{3}{4}$ inch per foot, the full-size shop draw-


ANCHOR
ANCHORS
ARCH
SPRING LINE OF ARCH
JOINT
Backjointed
1'-5" R.
5'-0½" R.
1'-4"
2'-0"
1'-0"
1'-0½"
1'-0"
3'-0"
10'-2"
5"
10"
do.

(a) Fig. 13 (b)

ings are drawn larger than the required size of the completed blocks. Thus, when it is desired to make a block 12 inches long, the shop drawings show it $12\frac{3}{4}$ inches long. The plaster model and resulting plaster cast will be $12\frac{3}{4}$ instead of 12 inches long and the pressed-clay block will be $12\frac{3}{4}$ instead of 12 inches long. After the block has been dried and burned, however, it will be found to have shrunk to about 12 inches, or the size required.

Shrinkage can be estimated quite accurately, but it sometimes varies as much as $\frac{1}{8}$ to $\frac{1}{4}$ inch per foot. Thus, a block estimated to shrink to an even 12 inches might prove to be when burned, $\frac{1}{4}$ to $\frac{1}{8}$ of an inch longer or shorter when it comes from the kiln. For this reason terra cotta blocks are cast with a lug at each edge, which can be cut or rubbed down by machinery to make the block the exact size required.

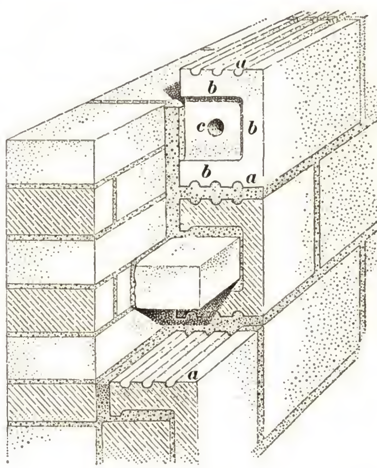


FIG. 14

The form of lug that is frequently cast on the upper and the lower edges of the blocks is shown at *a* in Fig. 14. At the ends of the blocks a form of lug is cast, as shown at *b*, and this projects beyond the face of the shell of the block *c*.

Variation in shrinkage is affected by the moisture or the stiffness of the clay when pressed into the mold, and by the dryness of the plaster mold in which the clay is pressed, since a dry mold will absorb more moisture from the clay than will a mold that is moist. Shrinkage of the block is also modified by the exactness with which the clay ingredients are mixed, by the atmospheric conditions while the block is drying, and by the varying degrees of heat in different parts of the same kiln.

37. Design of Steel Supports, Anchors, Etc.—All the loose steel and iron necessary to attach, or anchor, the terra cotta to the building proper, must be designed by the terra cotta manufacturer and shown on the drawings. He should also provide a schedule, or list, of all this iron and steel with his final drawings. Sometimes the contract requires that the terra cotta manufacturer provide all this steel work, but as a rule the steel contractor provides it according to the schedule and drawings prepared by the terra cotta manufacturer.

38. Final Approval of Manufacturer's Drawings.—When the manufacturer's shop drawings are completed, they should be carefully reviewed by the architect to see that the designs conform in every way with his details from which the shop drawings were made. These shop drawings should show the full sizes of all moldings, the general construction of the terra cotta, and the proposed methods of anchoring the blocks to the building. The jointing also should be indicated.

It may be necessary for the shop drawings to be changed a number of times before they meet with the approval of the architect in all particulars. He should carefully review the final drawings and approve them before they are handed back to the manufacturers.

MANUFACTURE OF TERRA COTTA

MATERIALS

39. Architectural terra cotta is made in somewhat the same manner as hollow tile or brick except that it is molded by hand, while hollow tile and brick are extruded by machine. Both are molded in clay and afterwards burned in a kiln. The manufacturer of architectural terra cotta requires a much more refined process than the manufacture of brick or hollow tile, the method is also more complicated, and the product must be worked with a larger amount of skilled labor.

Different types of clay are used in the manufacturer of terra cotta including marl, ball clay, and fireclay. Of these the first is almost invariably used alone, while the others may be used alone or blended with each other. Different varieties of each

type of clay may also be blended according to the nature of body which it is designed to produce.

40. Marl.—The marls are usually fairly hard rocks which break down readily under the influence of the atmosphere, and develop a high plasticity. During drying and firing they have a high shrinkage (about $1\frac{1}{2}$ inches to the foot) and are not subject to much warping when carefully manufactured.

41. Ball Clay.—Ball clay is commonly regarded as an impure kaolin, from which it differs physically in having a much greater plasticity and chemically in having an appreciably higher content of organic matter and alkalies. It is characterized by a low vitrification temperature and generally a high shrinkage on firing, together with a pronounced tendency to warp.

42. Fireclay.—The term fireclay in the foregoing classification of raw clays covers a diversity of materials, most of which is a fireclay that is found underlying beds of coal in coal measures, also clays having similar characteristics that are found in other geological formations.

43. Grog.—It is an almost invariable practice to add to the clay body about 30 per cent of burned clay that has been ground fine. This material is non-plastic and is termed *grog*. The general function of the non-plastic content of a batch of clay is to lend rigidity to the clay during the stages of manufacture, and to permit some control to be exercised over the properties of the finished ware.

44. Treatment of the Clay.—The clay is received at the factory and is allowed to weather, which causes it crumble and pulverize. It is then mixed with the grog. The mixture is then pulverized by special machinery, and afterwards mixed with water and treated in a pug mill until it becomes a smooth soft mass of material capable of being molded or cast. It can be kept in that state until required for use.

45. Manufacture of Blocks.—The prepared clay is taken to the pressing room, where it is pressed into the plaster-of-Paris molds and then artificially dried with hot air, a process

that usually requires from 2 to 3 hours. By this time the material has dried and stiffened sufficiently so that the blocks can be taken from the molds and handled without injury.

The raw blocks are then finished; that is, the seams are removed and the ornament is cleaned out.

If the blocks are to be finished with a smooth glazed surface, they are troweled smooth, and in this process the pores of the clay become closed and the finished surfaces of the material are made smooth and firm to receive the glaze.

Next, the blocks are placed in dryers, where they are subjected to hot air. This expels all moisture from the blocks, gradually making them bone dry. The drying takes about 48 hours.

The blocks then go to the glazers, where the exterior, or visible, surfaces are coated with a color or glaze as desired. They are then ready for burning and are taken to the kiln and subjected to a heat of from 1,000 to 1,250 degrees C. The burning process usually lasts from 12 to 14 days.

All terra-cotta blocks are made hollow, and the outside shell, which is usually 1 inch thick, is stiffened with webs, which are also about 1 inch thick. The number, size, and thickness of the webs and the thickness of the shell are determined by the size of the blocks, large blocks requiring a thicker shell and more webs than small ones. The voids are placed about 6 inches on centers.

Webs and shells of blocks have holes cast in them to facilitate anchoring them to the wall or structure. These holes also facilitate the handling of the blocks, as it is possible to pass the fingers through the holes when carrying the blocks. At the same time holes make the blocks lighter in weight and furnish a better bond for the mortar, which can flow into them and form a key.

MODELING

46. When the architect has approved the drawings and has marked them accordingly, the work of modeling the various blocks is then begun. The plain work in which no molding or ornament appears is given to the average workman. Those parts of the work that consist of ornamented moldings, panels,

cornices, brackets, and sculptural details are given to modelers of ability, whose duty it is to interpret the drawings in an artistic manner. Large manufacturers of terra cotta appreciate the importance of good models and usually employ only the most skilful men for this branch of the work. The results are that terra cotta work can be used where fine artistic work is required and that this material is not considered as a mere substitute for stone, but as a material capable of the finest artistic expression when used in accordance with its peculiar characteristics.

In Figs. 15 and 16 are shown pictures of modelers at work creating models for pieces of ornament. It will be seen that this work is of a highly artistic nature and demands the talents of real artists. The work is being done in clay, which must be kept moist to prevent shrinking and cracking.

47. Models.—Models are made for all ornamental pieces of terra cotta. These models are made of plaster-of-Paris, which forms the background, and moldings and the ornament are modeled in clay on the plaster backing. They are always made according to the shrinkage scale, that is, each 13 inches represents 12 inches in the finished product. The models of large pieces of ornament, panels, etc., are made without joints. The joints are put in later after the model has been finished and is ready to be cut up into blocks of convenient size.

48. Inspection by the Architect.—When the models are completed according to the drawings, the architect is notified; and if it is not convenient for him to call at the works and inspect the models, photographs are taken, a rule being laid alongside of each model to show the size and scale, and these photographs sent to the architect for inspection and approval. When this method is followed, two copies of the photograph of each model are usually sent to the architect, who indicates the suggested corrections and changes on each copy, returning one copy to the manufacturer and retaining the other copy for the purpose of comparison with a later photograph sent him after his suggestions have been incorporated in the model. If

Fig. 15

the later photograph indicates that the model is satisfactory, he notifies the manufacturer accordingly.

If the architect can visit the plant to inspect the models for the terra cotta, it will prove more satisfactory than to attempt

Fig. 16

to judge and approve the models from photographs, as he can better appreciate the form, size, and details of his design by seeing them executed at full size in clay. He can also suggest changes that he may wish to make and have these incorporated

in the clay and thus secure the desired effect. This done, he can approve the model and work can progress without further delay.

49. Cutting Up the Model.—After the model has been approved, it is cut into pieces of the right size from which to make the molds. The manufacturer usually determines the form and size of blocks that he considers best adapted to the design and to secure the best results in the burning. The jointing is indicated on the model or on the photograph that is submitted to the architect for his approval. Thus, an ornamental panel that may be 8 or 10 feet in diameter and in a single piece when inspected by the architect, might afterwards be cut into pieces not greater than 18 by 24 inches in size. The finished terra cotta comprising this panel will be cast in small blocks and combined to form the completed panel, all joints being filled with mortar.

If the joints are to be inconspicuous, the fact should be made known to the manufacturer before the model is cut into pieces, so that the joints may be cut around the ornaments, or that other steps may be taken to prevent the joints from showing when the different panels are built up.

50. Plaster Molds.—All ornamental and complicated work in terra cotta is first modeled in clay by competent artists. If the ornament is large it is modeled in one piece. After it has been approved it is cut into pieces of convenient sizes and a plaster mold is made of each different-shaped piece.

The molds are made in the plaster room. The model is laid on a bench or table, with the face side up and a wooden box is built around it.

Where the model shows ornament on two or more sides, the mold is made so that it can be taken apart to release the clay block and can be put together again so that another block can be formed in it.

51. Pressing.—Pressing rooms are equipped with small benches high enough so that, when ordinary molds are laid on them, the men can work in an erect position. Beside each

bench is placed an adequate supply of clay to insure no lost time in running out of material during the day's work. Over each bench is run a hot-air duct with various outlets, equipped with shutters. As soon as a piece is pressed it is moved over so that the hot air may strike the clay and dry it sufficiently to permit of the safe removal of the pressed piece. Pressing is entirely a hand operation. The clay is put in the mold and pressed into all corners and crevices by means of a kneading process. It is necessary that a presser have a large strong hand in order to do this kind of work properly. In placing partitions great care must be taken to insure proper bond between partition and face or side piece.

Partitions should be inserted with respect to the direction of the load to be carried.

52. Hand Cutting of Special Pieces.—When only one or two pieces of a certain shape or design are needed they are modeled separately in the clay. It would not pay to make a mold for one or two pieces.

In making panels containing names or other lettering, one method is used when the lettering is to be raised. In that case, ashlar of the proper dimensions is made up. A full-size paper detail of the letters is placed on the clay surface and the letters are picked through into the clay. The clay surrounding the letters is cut away, down to the proper distance. If incised or **V**-shaped letters are shown on the architect's drawing they are cut into the face of the clay.

53. Drying.—Terra cotta pressing is generally done in steam-heated rooms. When the clay has dried out slightly the piece shrinks away from the mold and can then be removed easily. It is at this stage that the seams left by the mold are removed by the finisher. The drying is then continued, usually by placing the pieces on steel racks which are transferred to a steam-heated room, where the drying is carried out slowly, the temperature rarely exceeding 30° C. In some factories the drying is performed in two stages, the first part being carried out very slowly in rooms which are artificially heated only in

cold weather, the ware being removed to a steam-heated chamber for final drying.

In this method of drying the exterior may become much drier than the interior of the piece during any of the stages. Unless the moisture loss be very gradual and even throughout the ware, the stresses set up may result in warping or fracture of the piece. The cracks produced in drying are often extremely minute and are not revealed until the ware has been fired.

54. Spraying.—After drying, the pieces pass before the sprayers, where the surface finish, glaze, slip or color is applied by an atomizer with compressed air.

55. Firing.—The final stage in the manufacture of terra cotta consists in firing to a temperature at which the constituent particles are well knit together but short of the point at which the mass of material vitrifies, or begins to melt. Muffle kilns are used for firing the terra cotta, from which the combustions are excluded; the heating is by radiation from the walls and floor of the muffle lining. Coal, oil, gas, or wood is used in firing the kiln.

The whole firing process may be conveniently divided into stages. The first stage is known as the water-smoking period, during which the mechanically mixed water, of which some always remains after drying, is driven off. This is one of the most critical stages in the whole firing period. If the temperature is increased too rapidly the difficulties which were mentioned under drying are met with on a greater scale. Stresses are set up in the material and warping and cracking ensue. At the same time the kiln must be efficiently ventilated; otherwise there will be an accumulation of steam in some parts of the kiln, leading to very unequal temperature distribution.

Following the water-smoking period comes the oxidation stage, during which carbonaceous matter and the sulphur of pyrites, if present, are burned out and ferrous compounds are oxidized to ferric.

Carbonates are decomposed and the chemically combined water of hydrated minerals is driven off. This period is characterized by the expulsion of considerable quantities of gas.

The next stage is the main shrinkage period, which gradually passes into the period of vitrification if the firing be taken to a sufficiently high temperature. It is at this stage that the bonding is produced by the sintering of the constituents. Both the degree and the duration of heating influence the bonding, and clay products require either a long treatment at a minimum temperature or a shorter treatment at a higher temperature.

The vitrification stage—which is usually avoided in the manufacture of terra cotta—marks the commencement of the fusion of the clay. The final firing temperature varies from about 1000° to 1250° C., according to the type of clay.

FINISHES AND COLORS

56. Texture.—Owing to the fact that terra cotta is formed of plastic clay, any finish or texture of the surface may be obtained by treating the block when it is being formed. Like pottery and faience, the clay may be tinted, and any color or blend of colors may be secured when it is burned in a kiln. It may be given any desired texture.

The texture of the terra cotta is called the mechanical finish and is obtained by reproducing in the face of the plaster model the surface to be matched.

57. Surface Finish.—Surface finishes with reference to texture may be as follows:

(*a*) Smooth
(*b*) Tooled or drove
  Eight lines to the inch
  Six lines to the inch
(*c*) Light irregular drag, or combing
(*d*) Heavy irregular drag, or combing
(*e*) Special—rugged, oak bark.

Surface finish or unglazed surfaces may be smooth or may be tooled with a light or heavy drag. Flat surfaces of sufficient width may be tooled, while the curved surfaces of moldings may be left smooth.

Surface finish for glazed ceramic finish, whether lustrous or mat, is usually made smooth.

58. Glazing and Color.—Ceramic colors, if unglazed, may be made on surfaces that are smooth or on irregular drag, or pitted, surfaces. If glazed ceramic finish is used for granite colors the surface treatment is usually smooth.

59. Ceramic Finish.—Ceramic finish designates the surface and color applied by the ceramic processes of coating, glazing, burning, etc. Four forms of ceramic finish will now be described.

(1) Unglazed terra cotta or terra cotta with a ceramic finish producing an unglazed finish made in various shades of buff, gray, salmon, red, and brown. Most colors thus made are vitreous.

(2) Glazed or enameled terra cotta, or terra cotta having an impervious ceramic finish of a glassy texture which may be either lustrous or mat, sometimes designated as full or dull glazes or enamels, made in various colors.

(3) Granite color terra cotta may be either

(*a*) Unglazed granite color: A mottled ceramic finish similar to unpolished granite.

(*b*) Glazed or enameled granite colors: A mottled ceramic finish similar to polished granite, made either lustrous or mat.

(4) Polychrome terra cotta or faience, or terra cotta having two or more colors on the same piece, may be

(*a*) Polychrome, unglazed, or unglazed terra cotta having two or more colors in the same piece.

(*b*) Polychrome, glazed, or glazed terra cotta having two or more colors on the same piece.

(*c*) Polychrome, blended colors, made only in glazed terra cotta. If, in polychrome glaze work, the colors are not to be separated by definite lines or contours or ornaments, but are to be blended together by brush treatment, or the like, the term "polychrome, blended colors" should be used. The character of work expected should be explicitly described by the architect.

For polychrome work the work to be done and the number of colors on a single piece should be clearly specified. An illustration of polychrome work is shown in Fig. 2.

(5) Fire-gilding produces a coating of gold glaze, either mat or lustrous, and fixed by an additional burning. The area of the surface to be gilded should be clearly specified.

60. Coating or Spotting of Terra Cotta.—In terra cotta the original mixture of clay has little influence on the final color, which is obtained by tints applied in the form of slips, or glazes. These glazes produce the plain colors such as are seen in polychrome terra cotta. The mottled finishes are obtained by spotting the surface or the slip with various colors to produce effects such as the mottled colors of granite or other stones of a spotted nature. Thus, by combining spotting and texture, endless variations are possible.

61. Glazing.—The final process of treating terra cotta before it is burned is known as *slipping* or *spraying*.

Terra cotta plants usually maintain a laboratory where the various clays, colors, and glazes are experimented with. Mineral colors are used in coloring and glazing and these materials do not look the same after they are baked as when they are applied to the unburned block. The burning produces a chemical change in the colors. Hence when seeking new shades of color the chemist applies the coloring material to a small briquette of terra cotta, burns it, and notes the results. The formulas for all mixtures of color and glaze are carefuly preserved, so that given colors can be reproduced at any time. When it is decided to use a certain color or glaze, the coloring materials are carefully weighed and mixed together in exact proportions with the greatest care according to the formula for that color. The colors are mixed with water and applied to the blocks before burning, by means of a spray from an air brush. With some glazes or where a full gloss is desired on the surface, it is sometimes necessary to put on an *under glaze* as a first coat, and apply the final glaze over this.

62. These glazes are used to furnish the colors required by the design and at the same time they make the surface of the terra cotta more or less impervious to water. There are four finishes that are usually specified by architects. These are

the *standard,* or *unglazed,* which is not wholly impervious to moisture; the *vitreous,* which is impervious to moisture; the *mat-glazed,* or *mat-enameled,* which is glazed, has a dull finish, and is impervious; and *full-glazed,* or *enameled,* which is impervious and has a glossy finish.

In addition to these standard finishes, terra cotta, as has been stated, can be treated in any desired shade or color, to form polychrome terra cotta. Different parts of the block may be treated with different colors. If not otherwise specified, most manufacturers base their estimates on the *standard color,* which is that of light Indiana limestone, and is unglazed.

63. In *standard* finish, the terra cotta blocks, after drying and before burning, are covered with a coating of clay *slip,* applied with an air brush. This produces a dull finish which is not "glossy" and the terra cotta so treated is not impervious to moisture, but has about the texture of good hard burned face brick.

In the *vitreous* finish, the glaze, or slip, is prepared with more of a glasslike quality by the addition of suitable minerals. This is also put on with an air brush, and two coats may be necessary to obtain the color desired, the first coat being a slip of one color to fill the pores of the blocks and the second coat a glaze of the same or another tint, depending upon the effect desired.

The glaze used in the vitreous finish vitrifies when burned; consequently, terra cotta with this finish is impervious to moisture. This glaze is, however, very thin.

Mat-glazed, or *mat-enameled,* finish, as its name suggests, is a dull glazed finish in which the glaze employed is of a glasslike nature but the finished blocks are not glossy. The glaze is heavier than that used on semiglazed terra cotta. The surface of mat-glazed terra cotta blocks is impervious, hence they are excellent for outside work where the weathering qualities of the blocks must be considered. Mat-glazed finish can be washed down as readily as full-glazed.

Full-glazed terra cotta blocks, as their name implies, are coated with what is practically liquid glass, which when burning

fuses and leaves a glossy finish excellent for its weathering qualities and because it can so readily be washed clean.

In all these ceramic finishes the coating fuses with the clay body in burning and forms a homogeneous mass.

The application of glaze to terra cotta is made at one of two stages. The most general practice is to apply the glaze, which consists of a mixture of fluxes and coloring ingredients very finely ground and mixed to a thin cream with water, to the ware when drying is completed.

Occasionally, however, the dried material is given a biscuit firing, and the glaze is applied to the lightly burned material, which is then refired at a higher temperature. The application is usually made by means of a compressor spray.

The compounding and application of glazes for ceramic ware are matters of considerable delicacy. The material must first fuse to a glass at a temperature closely approaching that at which the body is to mature in the kiln; the colors must remain pure, even when they are in contact with kiln gases.

FITTING AND NUMBERING THE BLOCKS

64. Fitting the Blocks.—After the terra cotta blocks have been burned they are allowed to remain in the kiln until they cool. They are then taken to the storage shed and the pieces are laid out on a floor in the order in which they will appear in the finished building, as illustrated in Fig. 17. The pieces are carefully fitted together to see that they are the exact size and shape called for by the shop drawings. Any pieces that are imperfect are sorted out and new pieces made to take their places.

When the blocks are laid out, every block in a string-course or cornice, lintel, or jamb is carefully placed to see that the length of the course is just right as shown on the plans. Thus, a cornice composed of many blocks of terra cotta is like one composed of cut stone, each piece of which must be carefully made from the architect's drawings so that when they are placed together and the proper allowance made for the mortar joints, the total length will meet the requirements of the drawings.

Some of the blocks may require to be cut down slightly, and to accomplish this result the lugs on either end, which are provided for this purpose, are cut with a chisel; or if the excess is very slight, as is usually the case, one or both ends of the blocks are rubbed down by machinery.

It is the usual practice to rub or cut down all adjoining edges of blocks whether any great excess of length has to be removed or not, as this treatment secures a true and square edge at the joints, consequently the lugs are formed sufficiently long to permit of this rubbing without cutting into the shell of the block.

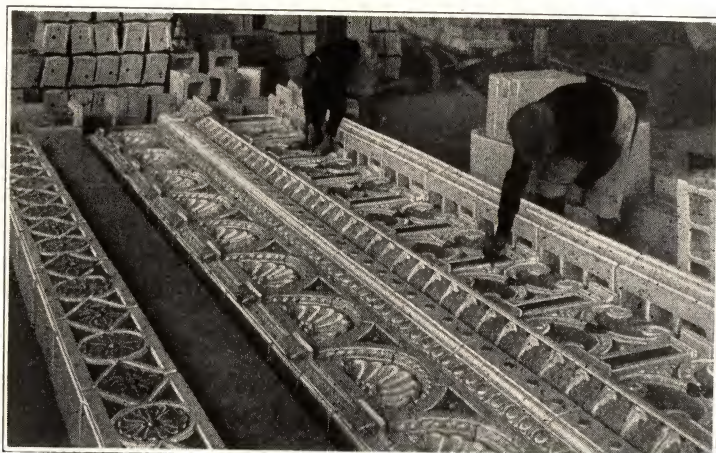


Fig. 17

To insure the proper inspection and jointing of the blocks by the manufacturer at the plant, however, the architect should incorporate in his specifications definite requirements regarding this work. This is desirable in order that imperfect pieces may be replaced as soon as possible instead of waiting for errors to be discovered at the building, when the work will be delayed while new pieces are being made.

65. Numbering the Blocks.—After the blocks have been fitted together at the factory, each piece is marked on the back with black paint. A diagram is then made which shows each block of terra cotta, and this is marked with letters and numbers

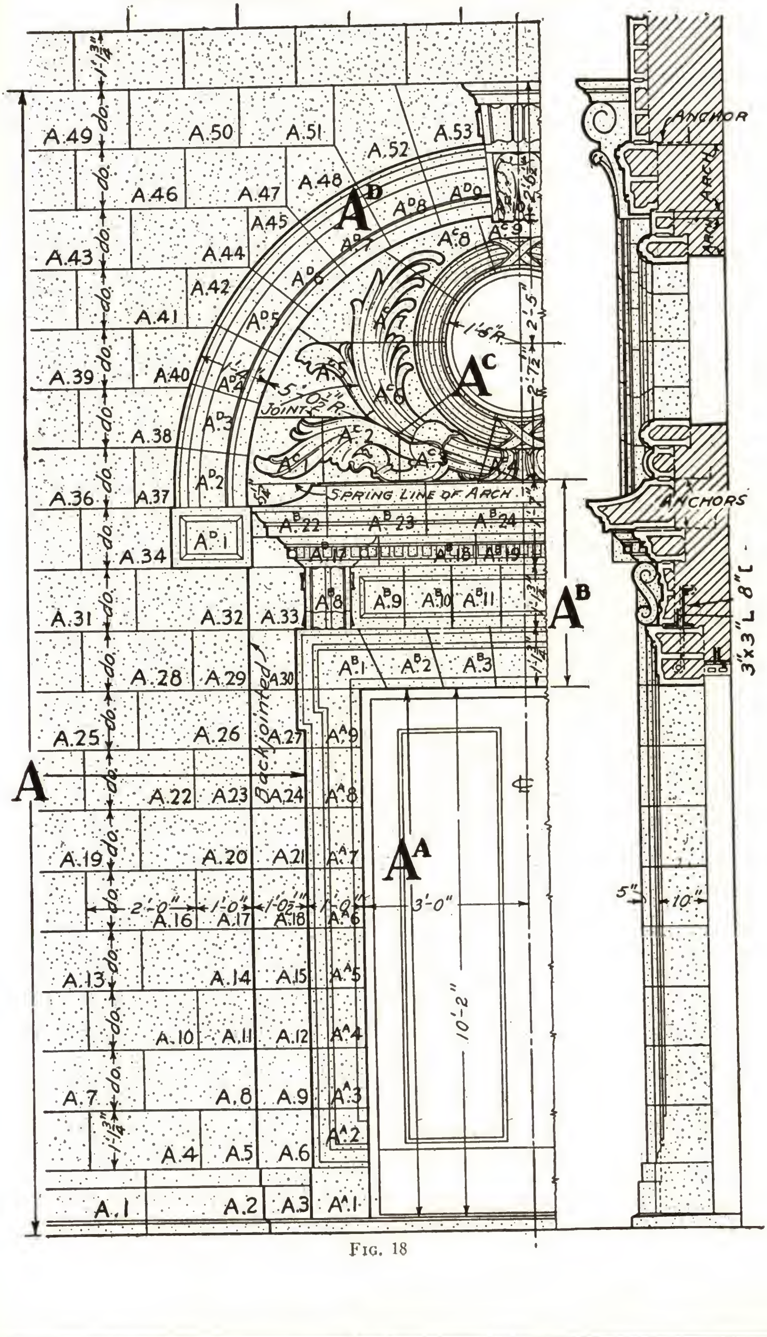

A
A.49
A.50
A.51
A.52
A.53
A.46
A.47
A.48
A.45
A.43
A.44
A.42
A.41
A.39
A.40
A.38
A.36
A.37
A.34
A.31
A.32
A.33
A.28
A.29
A30
A.25
A.26
A.27
A.22
A23
A.24
A.19
A.20
A.21
A.16
A.17
A.18
A.13
A.14
A.15
A.10
A.11
A.12
A.7
A.8
A.9
A.4
A.5
A.6
A.1
A.2
A.3
Back jointed
SPRING LINE OF ARCH
JOINT
1'-5"R.
2'-0"
1'-0"
3'-0"
10'-2"
ANCHOR
ANCHORS
3"x3" L 8" L
5"
10"

Fig. 18

to correspond with those placed on the blocks. This diagram is sent with the shipment of terra cotta to the building so that the workmen can readily assemble the blocks in precisely the same order in which they were fitted at the factory.

This assembling diagram, sometimes called the *setting plan,* usually consists of a blueprint of the manufacturer's scale drawing on which is shown every block and all the joints. Fig. 18 is an illustration of such a plan for the terra-cotta entrance shown in Fig. 13. The terra cotta of each story is usually indicated by a large capital letter, *A* representing the first story and *B* the second story, etc. Each special feature is represented by a smaller capital letter, which, in connection with the larger capital letter and a number, is used in marking each block.

Thus, the plain wall facing for the first-story wall is labeled *A,* as indicated in Fig. 18, and each block has a special number. The arch over the entrance is marked A^{D}. All the pieces of terra cotta forming this arch are marked A^{D} and a special number, as $A^{D}.1$, $A^{D}.2$, etc. This system of marking absolutely identifies each block and, having the setting plan and the number on each block, the contractor should have no uncertainty in picking out the blocks.

66. Another system of marking the setting plan and the blocks is illustrated in Fig. 19 which has some advantages in the way of simplicity. The different features of the building are lettered *A, B,* etc., but by this method all similar blocks have the same number. Thus, all the wall blocks are marked *A* and all the blocks shown marked *A 5* are of the same size and pattern, and all marked *A 4* are of the same size and pattern. Any block marked *A 4* can be taken from the pile and placed in any position marked *A 4* in the setting plan. In the system shown in Fig. 18 blocks *A 4*, *A 10*, *A 16, A 22*, etc. are all of the same pattern and are interchangeable, but they must be carefully sought and laid in the rotation indicated on the plan. Thus the mechanic must look after fifty or more numbers instead of eight or ten.

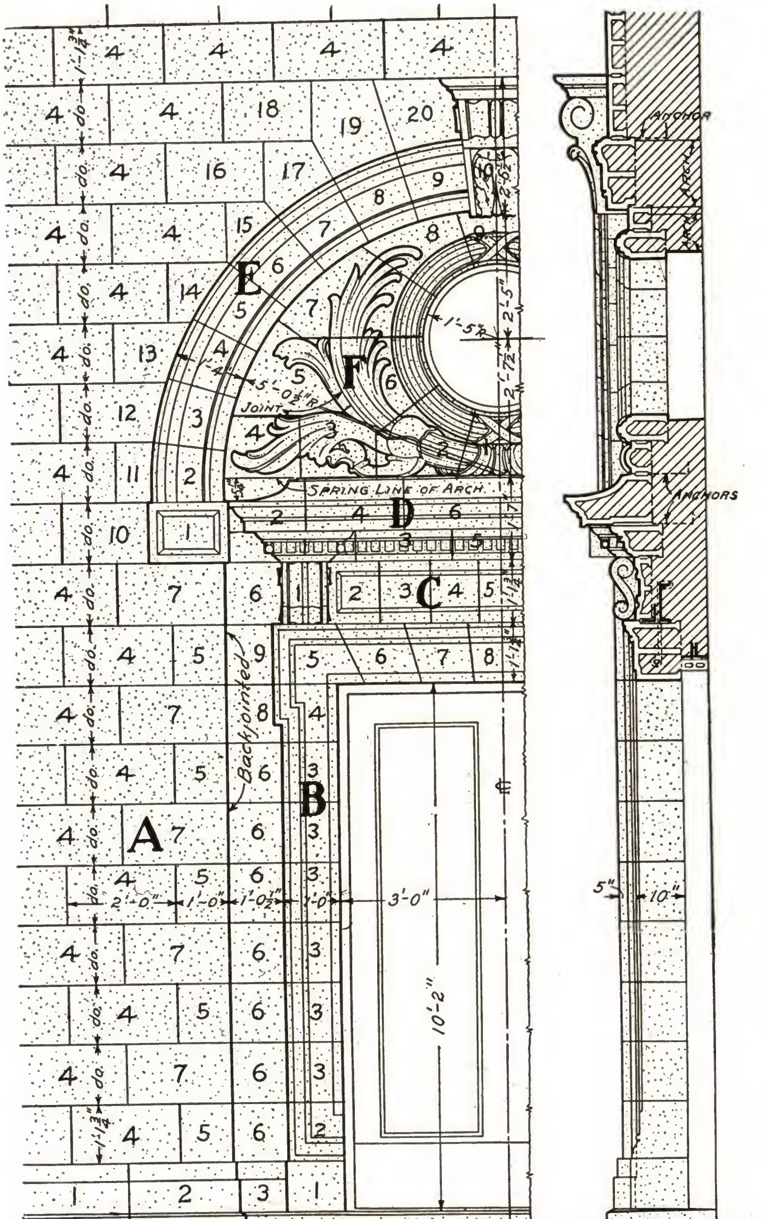

ANCHOR
ANCHORS
SPRING LINE OF ARCH
JOINT
Backjointed
A
B
C
D
E
F
5'-0½"R
1'-4"
1'-5½"
2'-0"
1'-0"
1'-0½"
1'-0"
3'-0"
10'-2"
5"
10"

Fig. 19

PRINCIPLES OF CONSTRUCTION AND DETAILS

67. Securing Terra Cotta to the Structure.—Since terra cotta is generally a veneer, it must be fastened to and supported by the general structure in some way. There are two methods of fastening terra cotta to the supporting structure: First, by bonding the blocks into the wall; and second, by fastening it to the structure by means of steel work in the form of ties, anchors, channels, angles, etc. The forms of steel used in this work are shown in connection with the various details or forms of terra-cotta work next to be considered.

68. Bonding Blocks into the Wall.—Buildings in which architectural terra cotta is used as a facing are naturally of masonry construction, that is, they are built of stonework, of brickwork, or of concrete or terra cotta block. The masonry walls may be self supporting or they may be supported on skeletons of structural steel or of reinforced concrete. The architectural terra cotta is attached to the masonry walls. The masonry walls or the skeleton constructions support the loads of the structure and its contents, while the architectural terra cotta forms a facing for the walls that beautifies the building.

69. Bonding Terra Cotta to Masonry Walls.—In buildings of brick or stone masonry faced with terra cotta, the facing blocks are laid up like brick or stone, each course being embedded in mortar on the course below. Each piece is anchored with galvanized or painted iron wall ties embedded in the main wall or anchored to the steel frame to hold the terra cotta securely in place. Fig. 20 illustrates the application of a terra cotta veneer to a brick wall, and shows the anchor *i* that holds one of the blocks in position against the wall. Most of the blocks are fastened to the wall in the same manner. The backs of the blocks are filled in solid with brickwork in cement mortar.

70. Bonding Terra Cotta to Concrete Walls.—Fig. 21 shows the method of securing a terra cotta facing to a solid concrete wall. In this construction the concrete wall is built first, and the anchor hooks, bolts, etc. are located and placed in

the wooden forms in which the concrete is cast. In this system of veneering, the blocks are held in place entirely by the anchoring. It is therefore very necessary that the anchors be installed with great care.

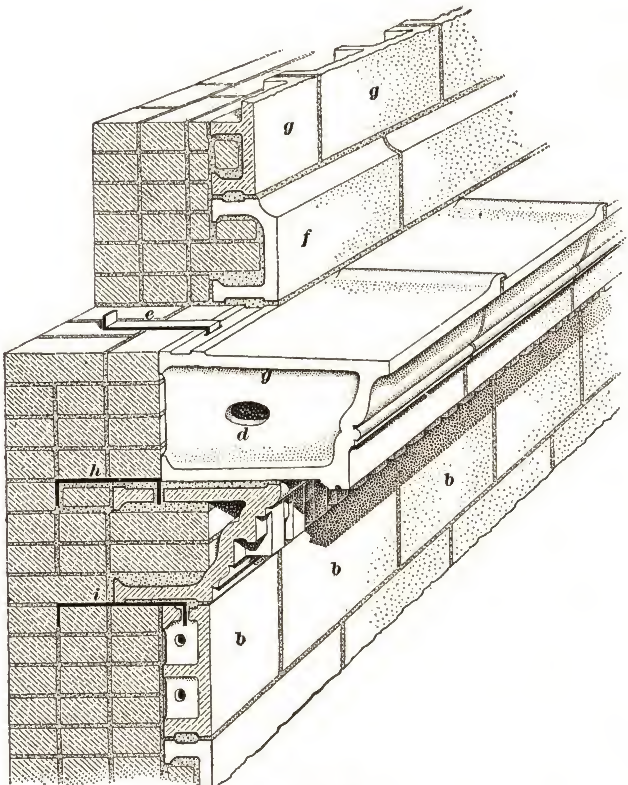


FIG. 20

71. Three systems of anchoring are shown in Fig. 21. In one system the hooked rod *c* is located so that it will come between the end shells of two adjoining blocks which are formed to fit accurately a horizontal round bar, as shown at *d*. This bar is sufficiently long to extend through the shells of both of the blocks and through the eye of the hooked bar. In this system, the hooked bars must be very carefuly located so that

they will come at these joints, otherwise they are not serviceable. In the second system of anchorage, the hooked bar *e* is turned around the horizontal bar *f*. This latter bar is located back of the blocks and the blocks are anchored at the top by pieces of iron as shown at *g*. As the bar *f* is continuous, anchors may be placed at any desired location horizontally.

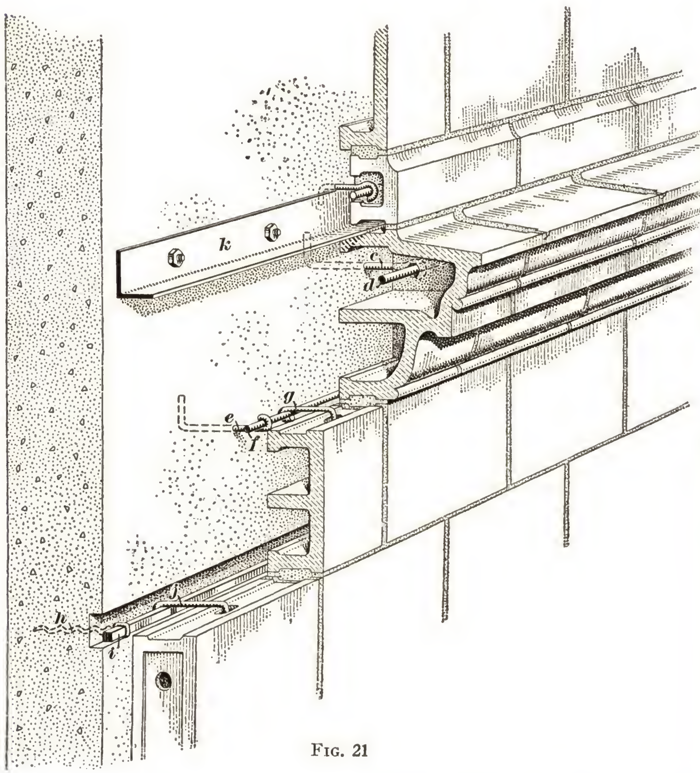


Fig. 21

The vertical location of this rod must be accurately determined to insure proper connections being formed. The third system is illustrated in the lower part of the figure. At *h* is shown a heavy wire which is left projecting from the wall surface. By means of this wire, the rod *i* is attached to the wall and fits into the recess that has been formed in the wall for this pur-

pose. The method of anchoring the blocks to the rod *i* is shown at *j*.

72. When terra cotta is used as a veneer and cannot be filled with masonry, special precautions must be taken to avoid overloading the blocks and thus causing them to be crushed or the edges to be chipped. Where the space between the wall and the blocks permits of the pouring of concrete, this space and the blocks may be filled with a cement grout, but this work should be done as the work progresses and not after the wall has been completed to a story height.

Terra cotta facings of the character mentioned are sometimes supported at intervals by means of angles such as shown at *k*, Fig. 21, called *shelf angles*. These are secured to the concrete structure by means of bolts which are placed in the concrete forms at the required locations before the concrete is poured, and after the forms have been removed the angles are attached to the wall by means of these bolts.

These angles must be accurately located and the lower flange should line with the horizontal joint in the terra cotta so that one course of blocks may have a direct bearing on the angle. The blocks resting on the angle should also be anchored to the angle, which is set away from the face of the building by means of washers. This permits of running wire behind the angle and securing the terra cotta blocks in place, or of the use of bent rods such as shown in Fig. 21.

73. Bonding Terra Cotta to Walls of Tall Buildings.—In tall buildings, especially those in which the horizontal dimensions are small in comparison with the height, slight motions may be caused by the pressure of strong winds. Differences in temperature also may cause slight movements of expansion and contraction in the building. These buildings are designed to offset any motion that may be caused by wind and are made as rigid as possible by suitable bracing in the framework.

The movements of tall buildings are relatively small but are sometimes sufficient to crack and break the facing material of the building. The facing, such as terra cotta, should therefore be attached or bonded to the outer walls of the building so that

the movements in the building will not cause the terra cotta to break.

74. Effect of Wind on Tall Buildings.—In Fig. 22 is a diagram of part of a tall building faced with terra cotta in which the effect of a strong wind on the building is shown in an exaggerated manner. When the wind is not blowing, the lines of the building will be vertical and horizontal and the facing will be in normal position. If, however, the building is swayed by a strong wind from the left, as indicated in the figure, there will

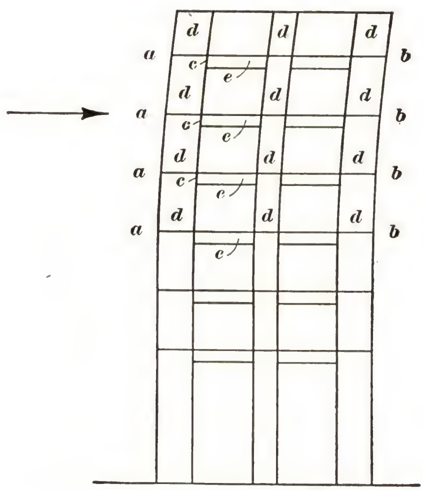


FIG. 22

be a tendency in the horizontal joints to open toward *a* and to close toward *b*. The closing of the joints may cause terra cotta blocks to crush each other.

There will also be motion at the points *c* between the terra cotta on the piers *d* and the spandrels *e*.

75. Effects of Heat and Cold.—Similar effects will be produced by the expansion and contraction that is caused by the heat of the sun and by cold. Slight vertical movements in the horizontal joints and sidewise movements in the vertical joints will be produced.

76. Methods of Preventing Damage to Terra Cotta Facing. Methods of preventing injury to the terra cotta facing of buildings, due to movements in the structure and to thermal conditions, have been devised. One of these methods is to divide the terra cotta surface into relatively small areas in which the movement will be small, and to separate these areas by wide joints called *expansion joints.* These joints are filled with elastic cement or mortar, which permits of slight movement without destroying the joint. The joint is so designed as to take up any possible motion in the small areas of terra cotta, without these areas coming in contact.

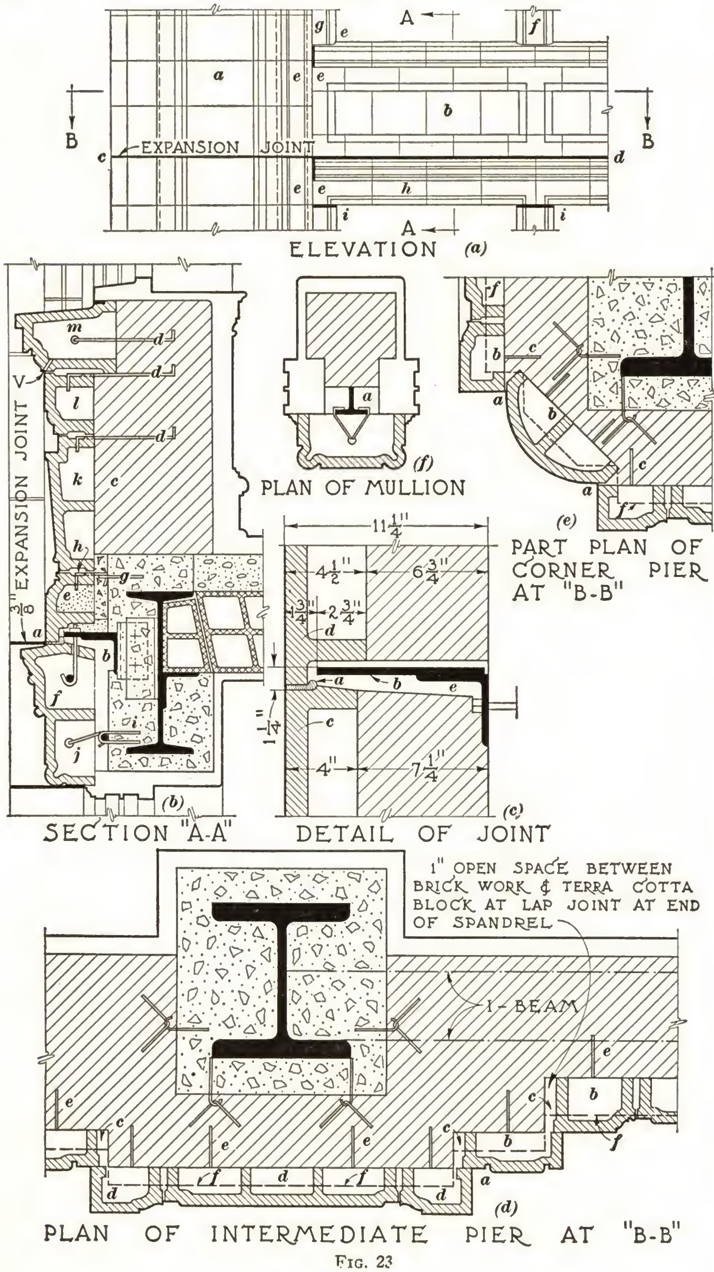
This method is based on the idea that the terra cotta is applied to the masonry construction as a veneer and that the terra cotta blocks do not extend into the masonry. The terra cotta blocks are, however, firmly anchored to the masonry and supported on steel shelf angles that are secured to the building. The supporting angles are placed at every story and support only one story of terra cotta.

This method of construction is illustrated in Fig. 22, in which the panels of terra cotta and the spandrels are shown at *d* and at *e*. Each panel *d* and *e* is supported on a shelf angle and each block is anchored to the wall. The shelf angles and expansion joints are indicated at *a b*. Vertical joints are shown at *c*. The vertical joints should be formed so that the spandrel panels, *e*, if they expand sidewise, will slide back of the pier panels *d* and thus avoid the crushing effect that would result if these panels pressed against each other. Joints formed in this manner are called *lap-joints* as they are formed by lapping one surface over another. Mastic cement must also be used in these joints.

The method is illustrated in more detail in Fig. 23, which shows details of a portion of a building having a steel frame and brick walls faced with terra cotta.

At *a* in (*a*), Fig. 23, is an elevation of part of a corner pier of the façade and at *b* is an elevation of a spandrel. An expansion joint is shown at *c d*, behind which is the shelf angle.

The shelf angle supports the pier panel *a* up to the corresponding level in the story above as well as the spandrel *b*, the



A
B
EXPANSION JOINT
B
ELEVATION (a)
EXPANSION JOINT
3/8"
SECTION "A-A"
PLAN OF MULLION
(f)
11 1/4"
4 1/2"
6 3/4"
1 3/4"
2 3/4"
1 1/4"
4"
7 1/4"
DETAIL OF JOINT
(c)
PART PLAN OF CORNER PIER AT "B-B"
(e)
1" OPEN SPACE BETWEEN BRICK WORK & TERRA COTTA BLOCK AT LAP JOINT AT END OF SPANDREL
I-BEAM
PLAN OF INTERMEDIATE PIER AT "B-B"
(d)

FIG. 23

mullion *f*, and the jamb *g*. The lintel of the window *h* is suspended from the shelf angle. Expansion joints are formed at the top of the mullions and jambs at *i*.

77. Details of Construction.—Details of this method of applying terra cotta are shown in Fig. 23 (*b*), which is a section through the spandrel in (*a*). At *a* in (*b*) is a section through the expansion joint and at *b* through the shelf angle. The terra cotta blocks are shown placed against the surface of the masonry wall *c*. Each block is firmly anchored to the wall by means of anchors *d*. The block *e* is anchored to the concrete fireproofing of the **I** beam by means of anchors *g* that are cast into the concrete with projecting loops into which the anchor *h* is hooked. Anchors *i* are cast in the wall and an iron rod is run through the projecting loops. Around this rod the anchors *j* for the terra cotta blocks are hooked.

The shelf angle is shown at *b* and supports the spandrel blocks *e, k, l,* and *m*. The lintel blocks *f* are suspended from the shelf angle by hooks of round iron, $\frac{1}{2}$ inch in diameter, that extend through the plate of the shelf angle. These hooks support a round rod of steel that extends through one or more blocks and they are adjusted by a nut that rests on top of the angle.

78. Details of Expansion Joint.—In (*c*), Fig. 23, is shown a large-sized detail of an expansion joint and a shelf angle. At *a* is the expansion joint between the blocks *c* and *d*. The block *c* is at the top of the panel that is supported by the shelf angle in the story below. The block *d* is the bottom block of the panel above, which is supported by the shelf angle *b*. The block *d* is firmly bedded in mortar on the shelf angle, and a lip projects downward and protects the edge of the angle.

The joint *a* should be at least $\frac{3}{8}$ inch wide and filled with mastic. The upper edge of the block *c* should have a curve molded in it so as to prevent the mastic from going too far back. It will also tend to turn the mastic upward and will form a better joint. Moreover, the block *c* should not be in contact with the shelf angle. An open space *e* should be preserved so that no load will come on the block *c*. The block

c and the panel below can then expand upward as already described. The shelf angles are indicated in plan in (*d*) and (*e*) by the broken lines *f*. The shelf angle in (*b*) is attached to the **I** beam.

The shelf angles in (*d*) and (*e*) are bolted to the masonry backing. To obtain the benefit from the use of shelf angles, the course of terra cotta resting on these angles should be set and

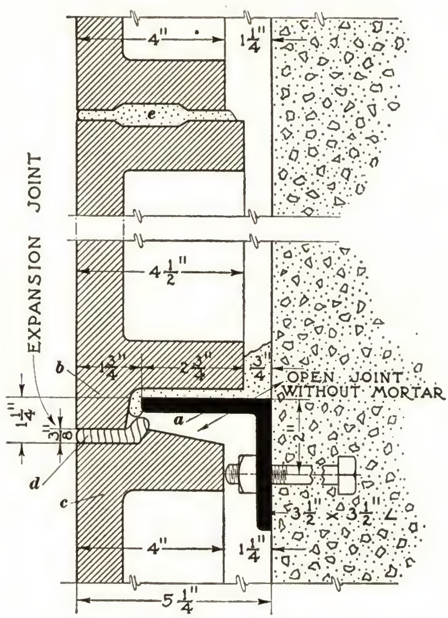


Fig. 24

properly bedded in mortar, before the terra cotta course immediately below the shelf angle is set. This is done to make sure that none of the weight of the terra cotta above the shelf angle is supported on the terra cotta below.

In Fig. 24 is a detail of an expansion joint and a shelf angle which gives clearly the elements and the construction of such joints. An angle is shown at *a*, supporting the block *b*, which is separated from the block *c* by the mastic joint *d*. A mortar joint is shown at *e*.

79. Details of Lap Joints.—At *a* in (*d*), Fig. 23, are shown lap or vertical joints between the piers and spandrels. If the spandrel blocks tend to expand or move sidewise, the blocks *b* will be forced into the pockets *c*, which should be formed in the construction for that purpose. If the terra cotta facing of the pier *d* expands horizontally the end blocks will tend to slide over the face of the spandrel blocks. The shelf angles are shown in plan by the broken lines *f* in the blocks.

In (*e*) is a plan of a corner pier showing the lap joints at *a*, and in (*f*) is a plan through a mullion. The **T**-iron *a* in (*f*) will be fastened to the shelf angle above and below and the mullion blocks *b*, in (*e*), can be tied to it as shown by the anchors *c*.

80. Filling of Blocks.—It will be noted that no filling is shown in the terra cotta blocks when used in the manner just described. Such filling would serve no purpose but would add considerable weight to the building. The terra cotta work is, however, carefully pointed and is practically weather-tight. The only blocks into which water may seep are sill blocks or blocks having upper surfaces to the weather. In the bottom of these blocks holes are formed through which any water that may enter the block will drip. A drip is shown in Fig. 23 (*b*) in the under side of the block *m*.

81. Protection of Steel from Corrosion.—The shelf angles and anchors, being of steel, must be protected from corrosion so that they will not rust away. When the blocks are filled with mortar that covers up the anchors, the anchors will be sufficiently protected. When, however, the blocks are not filled, the anchors as well as the shelf angles must be protected from corrosion by other means. All these steel parts should be dipped in asphalt or galvanized. In addition, a coat of rich cement mortar would be a great help. Two good coats of red lead or graphite paint covered by rich cement mortar will form a good protection.

82. Manufacturer's Advice.—The precise location and design of the blocks, joints, etc., should be problems for the

terra cotta manufacturer, who is aware of the conditions and who will naturally be interested in the stability of the terra cotta work. He should show in his working and setting drawings the desirable solutions for all these problems as well as the methods of anchoring and supporting the terra cotta facing.

In the system of construction previously described, a freedom of movement of the terra cotta facing should be aimed at. When the blocks are unfilled the anchors will permit of the necessary movement. The system of anchorage, together with the shelf-angle supports, when used as just described and shown, is sufficient to maintain the stability of the terra cotta work.

EXAMPLES OF THE USE OF TERRA COTTA

83. String-Courses.—String-courses are usually built into the wall as shown in Fig. 25. This example consists of two courses of terra cotta. The lower member *c* in (*a*) extends into the wall as far as the width of one brick and, since it has to support the weight of the construction above, it is filled in solid with brick and mortar. The upper course, shown at *d,* has a greater projection and also extends into the wall. Both these courses are filled with brickwork as far as the line of the wall face. The projecting part of the upper block is not so filled. Metal anchors of the form shown at *e* are used to tie the projecting blocks to the wall. The blocks have holes formed in the upper shell, as shown at *f,* to receive the anchors. Joints *a* and *b* between the blocks *d* are rectangular raised joints. Joint *a* in (*b*) is a segmental raised joint.

84. Cornices, Medium Size.—A medium-sized cornice is shown in Fig. 20. The wall supporting this cornice is faced with plain terra cotta blocks *b,* equal in thickness to one thickness of brick. The cornice consists of two rows of blocks. The lower blocks are richly molded and have a considerable projection in front of the face of the wall. This course must provide a certain amount of support to the upper course and therefore must be filled with masonry and anchored to the backing by anchors such as shown at *h.* The blocks of the upper course *d* extend back into the wall so that they may have good bear-

ings, or supports, and may be covered by the masonry above. This masonry resting upon the backs of the blocks prevents them from tipping outward. These blocks also support a considerable load of masonry, consequently must be filled with brickwork as far as the face of the wall. The projecting portion of this cornice is not filled with masonry, as it is desirable

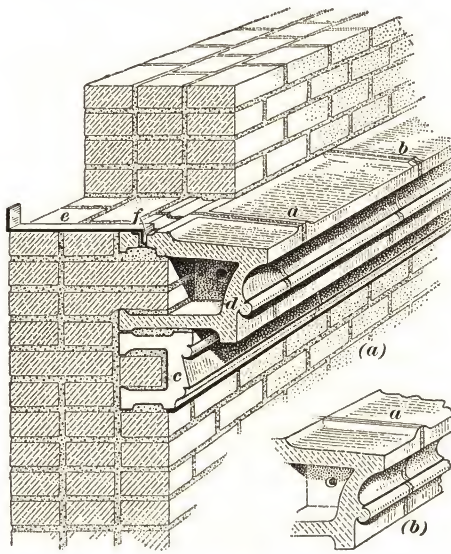


FIG. 25

that this part be as light as possible so that it will have no tendency to drop or tip. The blocks in this course should be carefully anchored to the brick wall as shown at *e*. The course *f* projects in front of the face of the wall. Above this course the wall is faced with the blocks *g*.

85. Large Cornices.—Large projecting cornices of terra cotta usually require to be supported by the structural-steel frame or by the solid masonry walls of the building. Cornices that are designed for buildings having a steel frame usually have an interior framework of steel shapes, and this frame is connected with the frame of the building in such a manner that the entire cornice is supported by the steel work of the

building. This form of construction is very complicated and the structural engineer who designs the frame of the building usually designs it so as to support the cornice properly. The terra cotta manufacturer will then design the secondary steel members that are required for his work.

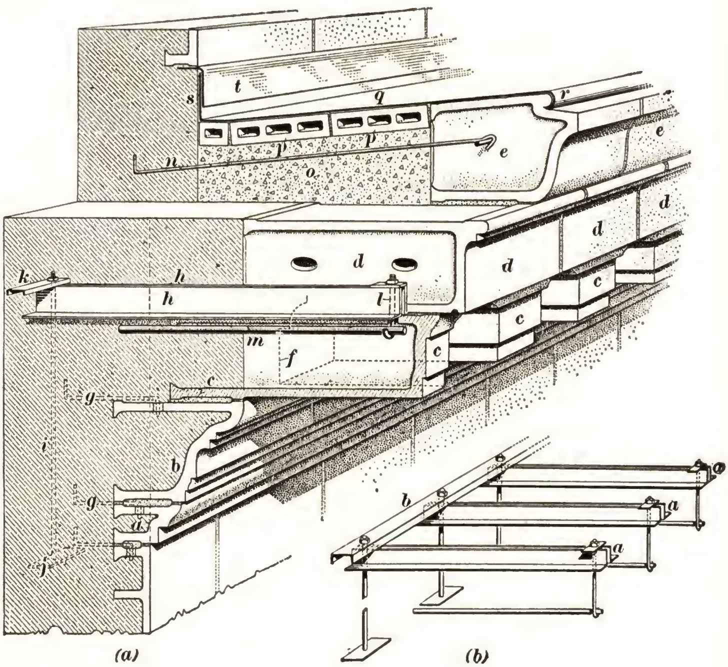


Fig. 26

86. Cornices for solid masonry walls, such as those illustrated in Fig. 26, are usually so designed that the lower members of the cornice will project somewhat to form a bracket or corbel on which the succeeding members, which have a greater projection, may rest. These lower members are filled with masonry and also anchored to the walls in the usual manner. The upper courses are provided with structural-steel forms *h* which are also anchored and secured to the wall. In this form of construction it is customary to extend the wall of the building to a sufficient height above the cornice to form a

mass of material that will more than balance the weight of the projecting portions of the cornice.

87. The blocks that form this cornice are indicated at *a, b, c, d,* and *e* in (*a*) Fig. 26. The outline of an additional block is indicated by the dotted line at *f*. This block cannot be shown in the view given, but occurs above the blocks *b* and fills the space between the brackets *c*.

The blocks *a* and *b* are filled with masonry and are also anchored by means of the tie-rods *g*. These blocks project beyond the wall surface and help to carry the brackets *c* and the wall blocks indicated at *f* between the brackets. The projection of the brackets *c* is so great, however, that the anchors and back filling are not sufficient to hold them in place. Steel angles *h* are therefore installed above each bracket to form a cantilever support. The angles are separated slightly to allow the rods to be placed between them for anchoring into the wall and for the suspension of the blocks. Wall anchors, one of which is shown at *i,* are provided to hold these angles in place and are usually several feet in length. Each anchor has a plate at the lower end, as shown at *j,* to anchor the rod to the wall. The upper ends of the anchors are fastened to the continuous channel *k* which runs parallel with the wall. By means of these anchors and fastenings, the steel angles are prevented from being pulled out of the wall by the weight of the cornice.

The bracket blocks *c* are supported and kept in place by a length of iron pipe *m* which is placed inside the bracket. One end rests on the brick wall and the other end is suspended from the channels by means of a rod *l*. This rod has a thread and nut on the upper portion. By turning the nut the bar *m* is raised until it comes in contact with the upper shell of the bracket and holds the bracket firmly in place. The blocks *d* are formed to fit over the angles *h* and rest on the brackets and the wall blocks between the brackets. The top members of the terra cotta cornice, shown at *e,* rest on the blocks *d* and are anchored to the wall by rods, one of which is shown at *n*.

In (*b*) is shown a perspective of the steel work used in this system of supports with the various members assembled. The

series of cantilever angles are shown at *a*, the continuous channel at *b*, and the anchorage and suspension rods as just described.

88. In Figs. 27 and 28 are shown vertical sections through terra cotta cornices showing further details of construction. In Fig. 27 is a cornice supported on a building of skeleton steel construction. A spandrel beam *a* supports the shelf angle *b* upon which the frieze block *c* is directly supported. The blocks

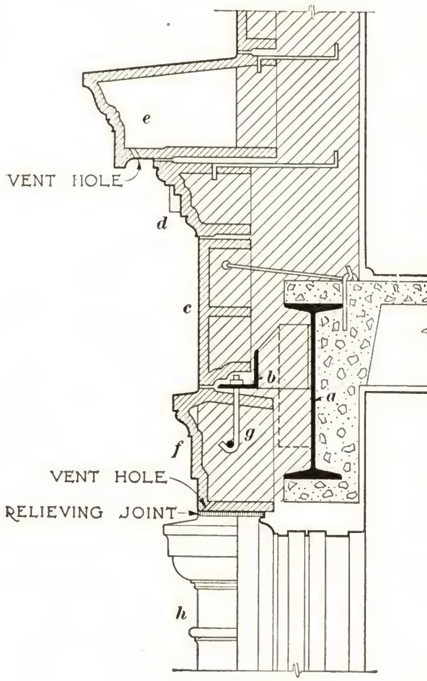


Fig. 27

c and *d* are filled with masonry, since they must support the top member *e* of the cornice. All these blocks are properly anchored as shown. The block *e* is filled only as far out as the wall above. This block is pierced with vent holes as indicated.

The lintel block *f* is supported by the anchor *g* and is pierced with vent holes.

All the above terra cotta work is supported directly on the shelf angle *b* and by the anchors indicated. Between the lintel *f* and the pilaster cap *h* a relieving joint is shown. This is provided to prevent the lintel from resting on the pilaster. This pilaster will be supported by a shelf angle in the same relative position in the story below.

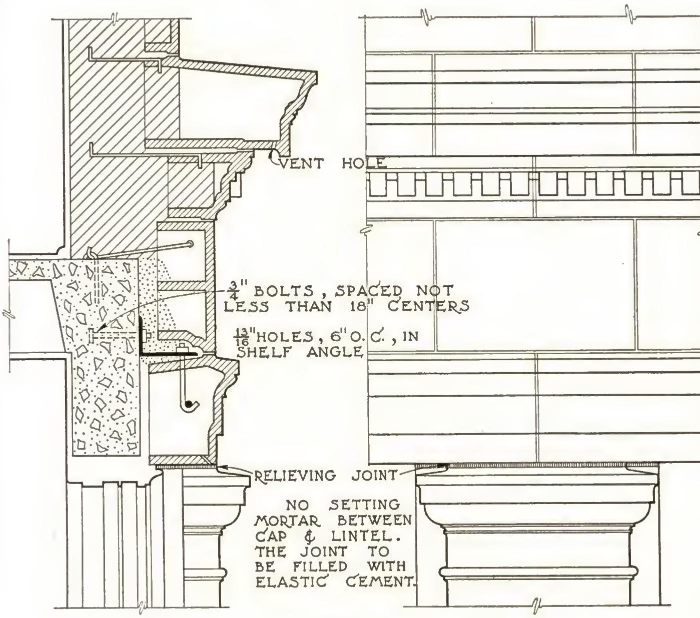
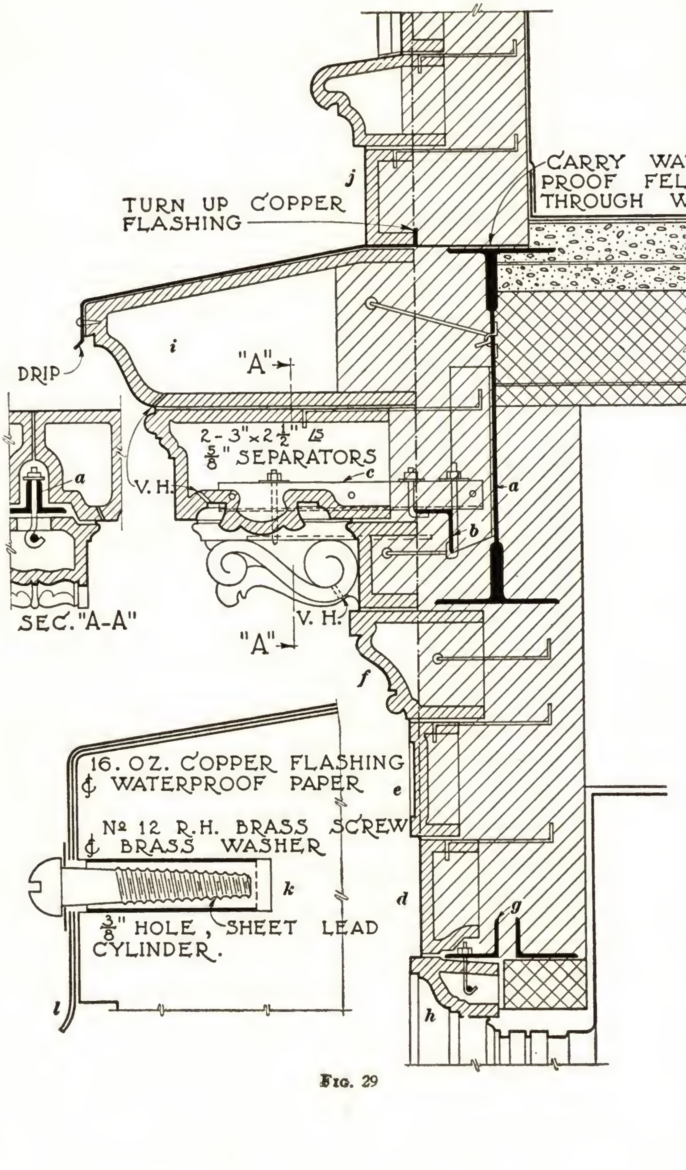


Fig. 28

89. In Fig. 28 is shown a section through a similar cornice supported on a concrete structure. The principal difference from the detail in Fig. 27 is that the shelf angle is supported by bolts that are cast in the concrete. The shelf angle is afterward secured to these bolts, which project in front of the concrete lintels.

90. In Fig. 29 is shown a section through a terra cotta cornice that is more complicated in structure and therefore illustrates additional points. A beam formed of a plate and angle is shown at *a* and supports the angle at *b*. This angle is



CARRY WAT PROOF FELT THROUGH W
j
TURN UP COPPER FLASHING
i
DRIP
"A"
2 - 3" × 2½" ∠S
⅝" SEPARATORS
c
a
V. H.
a
b
SEC. "A-A"
V. H.
"A"
f
16. OZ. COPPER FLASHING
¢ WATERPROOF PAPER
e
No 12 R.H. BRASS SCREW
¢ BRASS WASHER
k
d
⅜" HOLE, SHEET LEAD CYLINDER.
g
l
h

Fig. 29

arranged to support the angle bracket *c,* which projects beyond the face of the wall and supports the soffits and modillions of the cornice. The members *d* and *e* of the frieze, and the bed mold *f,* are supported on the shelf angle *g* from which the lintel block *h* is suspended. A method of flashing the cornice so as to prevent water from entering the large blocks *i* is shown. This flashing should be of sheet copper or lead and should be turned up under the block *j* and brought down over the outer edge of the block *i* as shown. A method of fastening the flashing to the cornice is indicated, at a large size, at *k.* The flashing is turned down and extends below the edge of the cornice as shown at *l,* forming a drip that will prevent the water from getting beneath the flashing. This flashing is fastened by brass screws that are screwed into lead tubes let into the face of the terra cotta. Brass washers are placed against the flashing under the screws. Holes are formed in the terra cotta blocks, when modeling them, to take the screws.

91. Lintels.—In Fig. 30 is shown an entrance to a building which has walls faced with terra cotta. The jambs and lintel of the opening are also formed of the same material. Since the terra cotta is only a veneer for the brickwork, it is necessary that steel supports be provided to carry the terra cotta as well as the brickwork over the opening.

Fig. 31 (*a*) represents a section taken through the center of the lintel over the entrance shown in Fig. 30. The steel supports that carry the masonry and terra cotta consist of three angles, as shown in Fig. 31 (*a*) at *a, b,* and *c,* and one channel *d.* The angles *a* and *b* carry part of the brick wall, and the angle *c* and channel *d* carry the remaining part of the wall and the terra-cotta lintel. The steel member *d* supports the terra cotta lintel course *e,* which is suspended from the steel by means of rods *f* and anchored by the anchors *g* so that it is perfectly strong and rigid.

In this figure, sections are shown through the blocks which form the courses *e, h,* and *i* to illustrate how the blocks are formed to fit around the steel work and to show the rods and anchors that secure them in place. In (*b*) is shown a view of

the steel supports *a, b, c,* and *d* that hold up the lintel. At *e* is shown one of the rods that carry the lower course of terra cotta. These rods are placed between the blocks of the lower course of the lintel, the upper ends of the rods are secured to

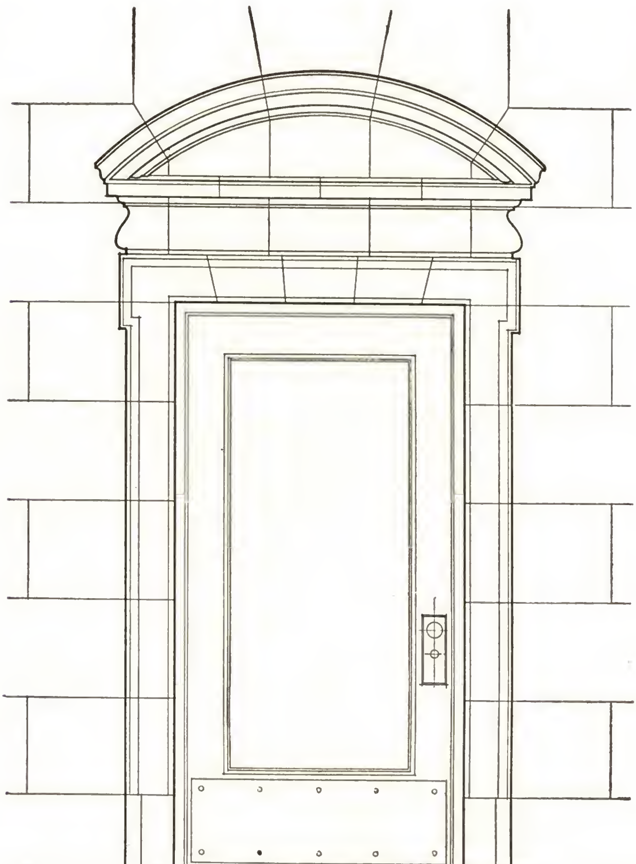


Fig. 30

the steel channel by means of clips *f,* and the lower end is bent around the short bar *g,* which extends through the end shells of two adjoining blocks. At *h* is shown a rod which is formed around the bar *g* and also over the horizontal flange of the angle

a. This rod prevents the block from tilting when the succeeding course of terra cotta is put in place on top of it. At *i* and *j* are shown the galvanized iron bars that are used to anchor the terra cotta blocks *h* and *i* in (*a*) to the steel lintels.

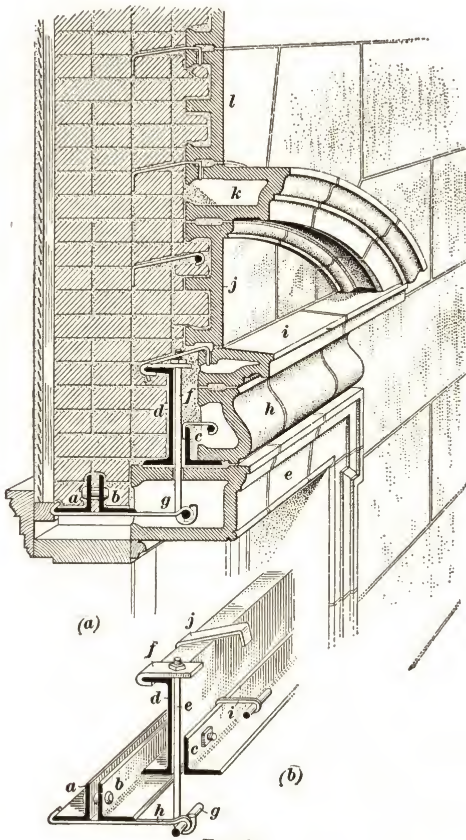


Fig. 31

The terra cotta blocks *j*, *k*, and *l* in (*a*) are bonded with the brick wall and also anchored by bars as in the regular form of construction.

The terra cotta lintels of the entrances shown in Figs. 3, 4, and 5 are all formed of courses of blocks and carried by steel members that are concealed in the masonry, thus permitting the

exposed under side of the lintel, called the *soffit,* to be finished to correspond with the jambs, as is shown in Fig. 7. The principle involved in the construction of these lintels is the same as that shown in Fig. 31, the form of the blocks and the steel work being adapted to meet the requirements of the different designs.

92. Window Mullions.—Window mullions or slender piers that are formed of terra cotta or have a facing of that material, should be provided with steel posts formed of **T**'s, angles or gas pipe, to which the terra cotta may be anchored, and which will give stiffness to the piers.

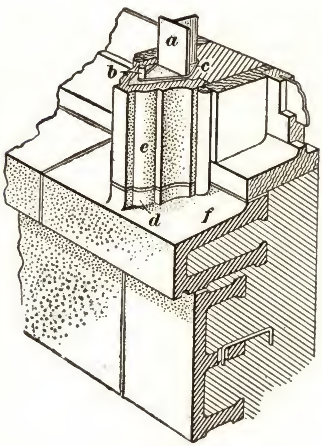
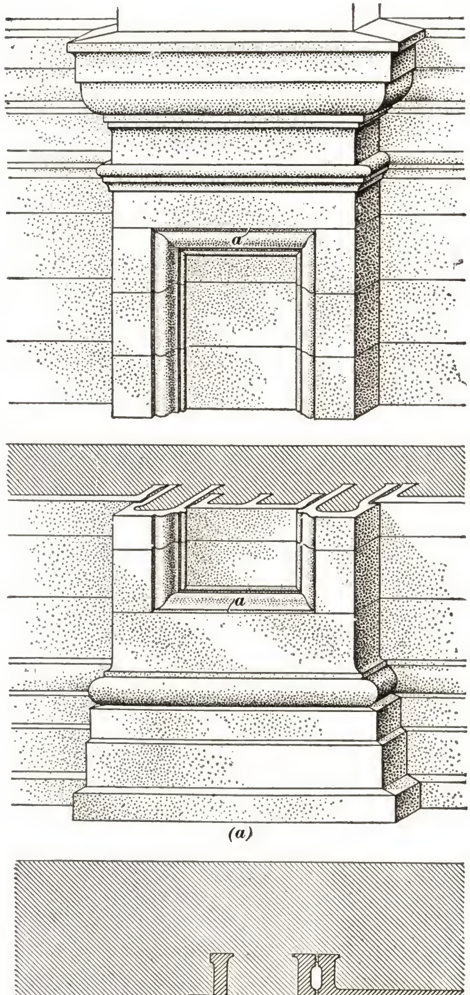


Fig. 32

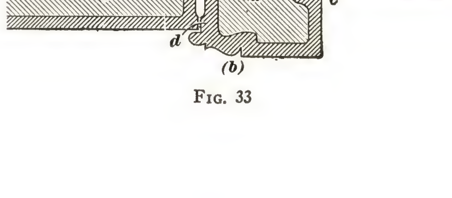
In Fig. 32 is shown a mullion that has a terra cotta facing. A steel **T** bar *a* is used to reinforce the mullion. A short iron bar *b* is placed in an opening in the top of the terra cotta block and this is anchored to the **T** bar by means of a heavy wire. The bar *b* extends into the bottom shell of the succeeding block and into the brick backing *c*. Round or square bars of iron are sometimes used as anchors, one end being formed to turn down into the opening in the top of the block and the other end being formed to fit around the **T**. This method, however, does not anchor the bottom end of the succeeding block.

In this illustration it will be noted that the lower part *d* of the mullion is formed on the terra cotta sill-course. This is done to secure a level bearing for the block *e,* as the sill is formed with a slope, as shown at *f*.

Examples of mullions which have steel reinforcement are shown between the second-story windows of the building illustrated in Fig. 3, and between all windows of the residence shown in Fig. 9. This reinforcement is absolutely necessary for the mullions shown in Fig. 9, as the mullion is too small to permit of sufficient masonry backing to give any strength to the



(a)



(b)

Fig. 33

terra cotta or to permit of anchoring the various mullions. The transom blocks which form the bars shown in this illustration are also reinforced with steel.

93. Pilasters.—In designing pilasters, the forms of the blocks and the manner of jointing them where they intersect with wall blocks require particular consideration in order that the vertical joints may be concealed or, at least, may not be easily seen.

The pilaster shown in Fig. 33 has a paneled face and each course in this face in the width of the pilaster is formed of three pieces. The panel is formed of one piece and the side members of the other pieces. At *a* in (*b*) is shown a plan of one side piece, and at *b* a portion of the panel. At *c* and *d* the manner in which the block is formed to conceal the vertical joints is shown. The moldings at the top and bottom of the panel, as shown at *a* in (*a*), are formed on the same blocks as the top and bottom sections of the panel.

The pilaster shown in Fig. 34 (*a*) has horizontal joints known as *rusticated joints*. This is a very practical design for large blocks, as a slight warping of the blocks in the burning is less apparent than in the plain smooth-faced pilasters. In the rusticated design, the horizontal joints between the blocks are not conspicuous, as they are located at the tops of the recessed surfaces between the projecting parts of the blocks. This design requires a somewhat different form of joint, however, at the intersection of the pilaster with the wall, as one part of the block projects beyond the other portions. In (*b*), at *a*, are shown these projecting parts, and at *b* is shown the return which is formed on the wall block *c*. In (*c*) is a view of this joint, showing the projecting part of the wall block *c* extending behind the similar portion of the pilaster block. The portions *d* and *e* of the joint will appear as shown. These joints should be made as thin as possible so that they will not be easily seen. This form of block allows of a square joint between the two intersecting blocks instead of a miter joint, and any cutting of the blocks that is necessary to make them fit properly may be easily done without disfiguring the joint.

94. Columns.—Columns of terra cotta are built up in sections from 10 to 16 inches in height, called *drums,* from their cylindrical drumlike shape. For columns not exceeding 14 inches in diameter these drums can be made in single pieces.

In the case of columns of large diameter, it is not practical to make the drums in one piece, as slight inequalities of shrinkage

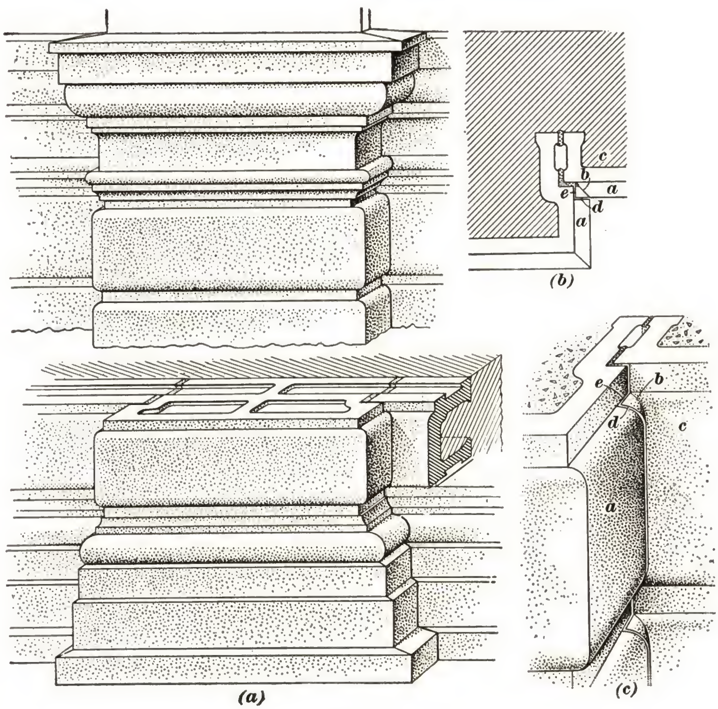


FIG. 34

are likely to occur. The best practice is to use a sufficient number of vertical joints to make the drum of four or more pieces, depending upon the diameter of the column. When all the drums are built up of four or more pieces, as in (*b*) and (*d*) Fig. 35, the vertical joints should be continuous for the whole length of the shaft wherever practicable. The heights of the courses should not exceed 16 inches.

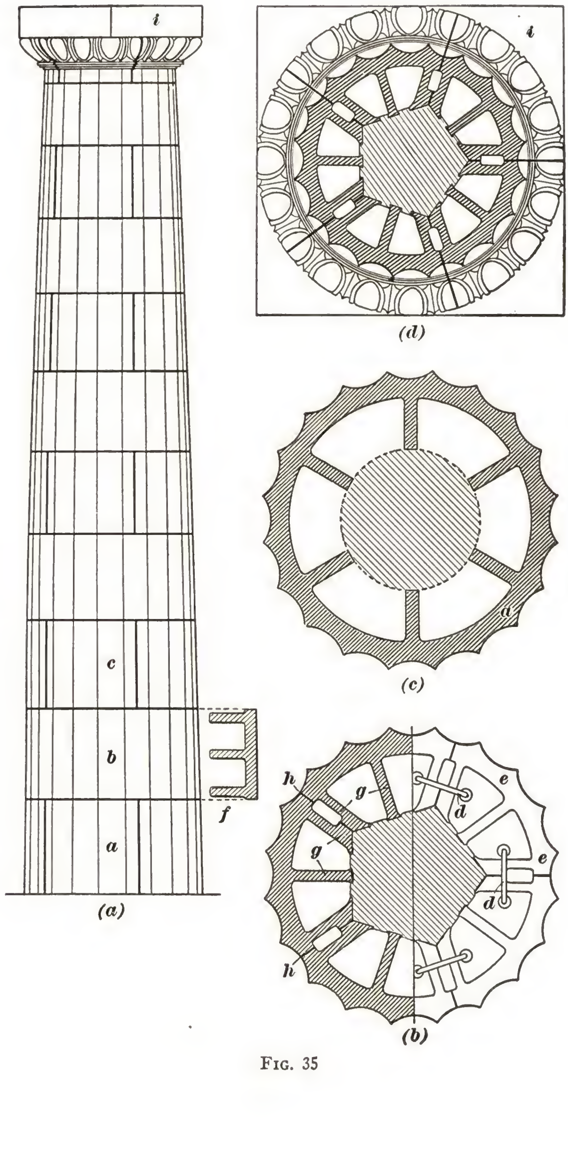


Fig. 35

If the terra-cotta column is to enclose a structural-steel column, the drums must be made in pieces so that they can be placed around the steel column.

95. In Fig. 35 (*a*) is shown a terra cotta column of small size, in which the drums can be made in one piece if desired. The drums are shown at *a, b, c,* etc. The drum *b* is in one piece, and *a* and *c* are each in five sections. A plan of the drum *b* in (*a*) is shown in (*c*) and a plan of the drums *a* and *c* in (*a*) is shown in (*b*). The plan (*b*) shows the outer shell upon which the flutes are cast, also the radiating webs and the vertical joints between the sections. The right-hand side of the plan shows the top of the block with anchors *d* holding the blocks together, also the raised parts of the bed joints *e,* which are ground when necessary to make the blocks fit together. At *f* in (*a*) is a vertical section through a block, showing the horizontal ribs and the raised joints that are shown in plan at *e* in (*b*). The left-hand side of the plan (*b*) shows the radiating webs *g* and the joints *h.* The capital is generally made in sections. A plan of the capital of the column, in which the observer is looking upwards, is shown in (*d*). The ornamental portion of the capital is divided into five parts and the square abacus *i* into four parts.

When the column is built, the center of the column is filled with masonry. Concrete is the cheapest and best material to use for this purpose. A column such as the one just described is not strong and should not be expected to support a great load. When there is a considerable load to be supported a steel column should be placed inside the terra cotta one in the manner that will be described later.

96. A design of column known as a *banded column* is shown in Fig. 36 (*a*). With the exception of the base *a f* and the capital *b,* the sections that form this column are all of the drum shape, made without vertical joints. The advantage of this design, for terra cotta construction, is that the plain sections *c,* being located between the fluted sections *d,* conceal irregularities in the flutes that may be caused by the burning and which would be apparent were these fluted sections placed together. The

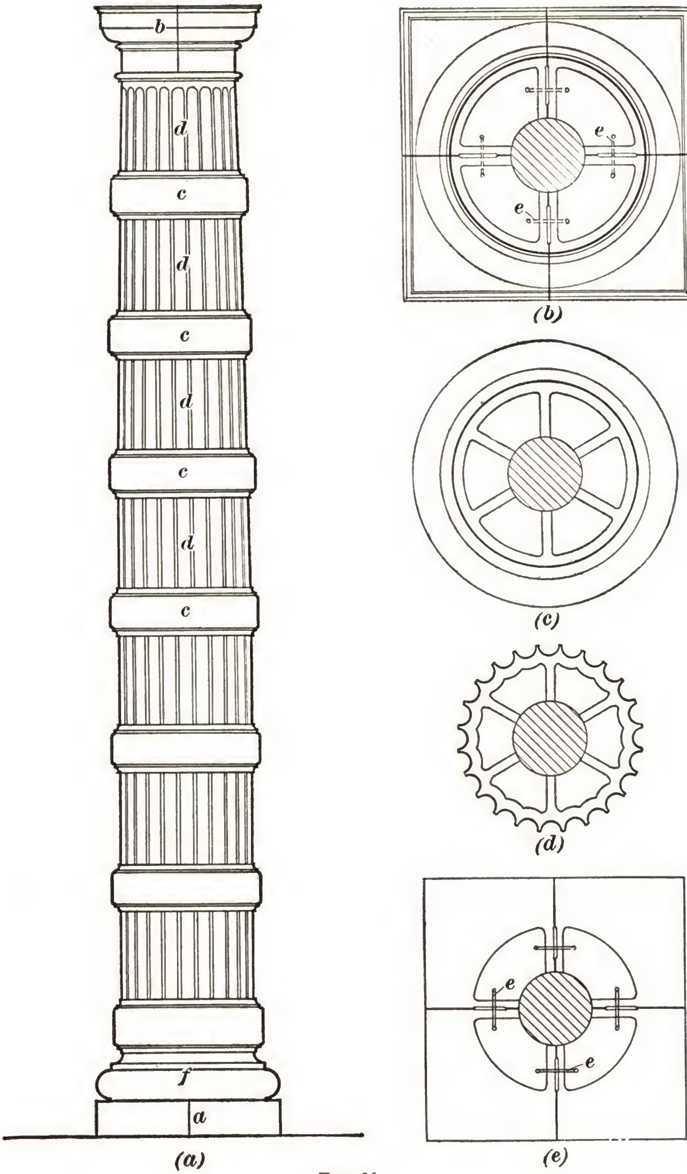


FIG. 36

forms of the shell and the interior webs of this column are similar to those of the column shown in Fig. 35.

A plan of the base block *a* in (*a*) is shown in (*e*). A plan of the cap viewed from the under side is shown in (*b*). Both base and cap are formed of four pieces which are clamped together as shown at *e* in both these figures. The clamps are shown in dotted lines, as they occur on the upper side of the capital and could not be seen in the view given. A plan of the circular portion *f* of the base is shown in (*c*), and the plan (*d*) represents the fluted drums *d* in (*a*).

97. Columns that are required to support a weight in excess of the load the terra cotta will safely carry should be provided with a structural-steel column in the center. If the terra cotta column is small and the sections are in single drums it will be necessary to erect the steel column first and lower the terra cotta drums down from the top over the steel column.

Columns of large dimension cannot be economically or successfully formed in single drums, but must be built up of segments. Columns of this character usually contain structural-steel supports, and the terra cotta segments must be designed to fit around the steel work which has been previously erected.

To conceal the vertical joints as much as possible in the completed column, frequently flutes and beads are employed in the design and the vertical joints are located in these members. Segments that form the columns should be anchored together by means of iron clamps hooked down into holes cast in the shell or webs of the units and the hollow spaces in the blocks should be filled with brickwork or concrete.

98. In Fig. 37 (*a*) is shown a fluted column having a molded base and an ornamental capital. This terra cotta column encloses a steel structural column and is of a large diameter. The base, shaft, and cap are formed of several units and the joints between them are indicated in the illustration by heavy lines.

In (*a*) is shown the complete column. The base block *a* is formed of four parts, as in the square part of the base shown in Fig. 36. The molded base *b*, Fig. 37 (*a*), is shown in plan

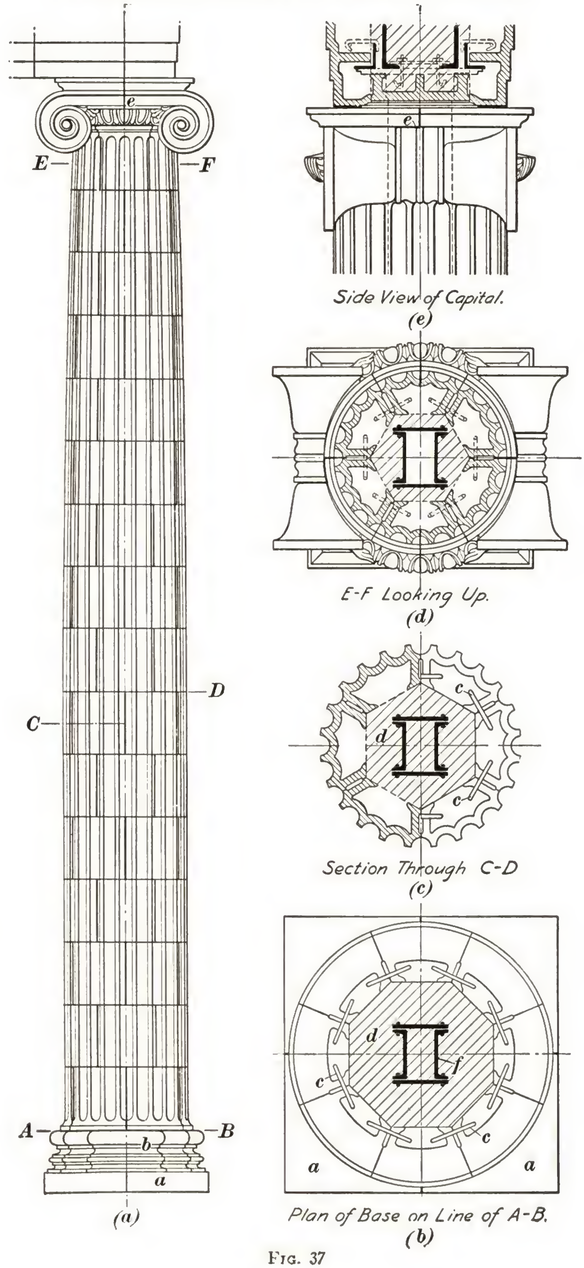

e
E
F
D
C
A
B
b
a
(a)
Side View of Capital.
(e)
E-F Looking Up.
(d)
c
d
Section Through C-D
(c)
d
f
c
a
Plan of Base on Line of A-B.
(b)

Fig. 37

in (*b*) and is formed of eight segments which are bonded together by means of iron clamps *c*. A section through the fluted shaft of the column, taken on the line *CD* in (*a*), is shown in (*c*), six segments being used to form the drum. These are also anchored together by means of clamps *c*.

The right-hand part of this section is taken through the joint and therefore the clamps *c* can be seen. The left-hand side of the section is taken through the middle of the block and shows the concrete or cement filling at *d*. A plan of the under side of the cap, taken at *EF*, the observer looking up, is shown in (*d*); the heavy lines indicate the jointing of the four parts that form the cap. Joints on one side of the cap are shown at *e* in (*a*) and those of the other side of the cap are shown at *e* in (*e*).

The steel column around which the terra cotta column is formed is shown at *f* in (*b*), and the space that is filled with concrete or brickwork is shown at *d*.

In Fig. 4 are shown columns that have structural-steel members in the cores. These columns are designed so that the vertical joints between the blocks occur at the angles of the columns and are thus partly concealed by an ornamental beaded treatment.

99. Balustrades.—Vertical members of terra cotta, such as balusters, urns, finials, etc., are usually formed of small pieces and held together by round iron rods extending up through hollow cores in the centers. On each end of these rods is a nut and washer, and when the top nuts are tightened the different pieces of terra cotta that compose the baluster or finial are drawn closely together.

When balusters are short, each can be cast in a single piece having a hollow core to receive the rod and to permit of proper shrinkage in the burning. Long balusters can be molded in halves, which, after drying, are placed together and the joints smoothed off and finished so they will not show. The completed baluster is then placed in the kiln and burned. When a long baluster consists of a base, shaft, and cap, however, joints are formed in the baluster so that it may be cast in three pieces, each

of which is small. The twisting and warping due to burning is thus reduced to a minimum.

Balustrades are formed of a series of balusters which rest on a terra cotta base and are covered at the top by a terra cotta cap, or railing, and the balusters are anchored to this base and cap to make a strong and rigid construction.

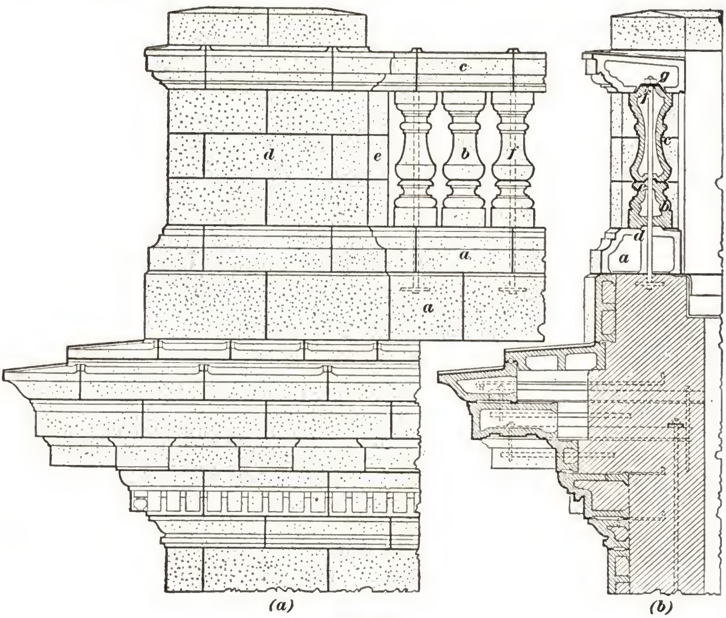


Fig. 38

100. A portion of a balustrade of this description is shown in Fig. 38 (*a*) and a section through the balustrade and one of the balusters is shown in (*b*). In (*a*) an elevation of the base on which the baluster rests is shown at *a*, the baluster at *b*, and the cap, or railing, at *c*. The balustrade terminates at the end of the building in a pier as shown at *d*. This pier is faced with regular-shaped terra cotta blocks and is constructed in the same manner as terra cotta faced walls. At *e* is a plain pilaster adjoining the pier.

The dotted lines at *f* indicate a rod that extends from the base, through the baluster, and into the cap. In this illustration

the rods are inserted in every other baluster instead of in each one. In (*b*) is shown a section through the balustrade in which the baluster is shown to be formed of two parts, *b* and *c*.

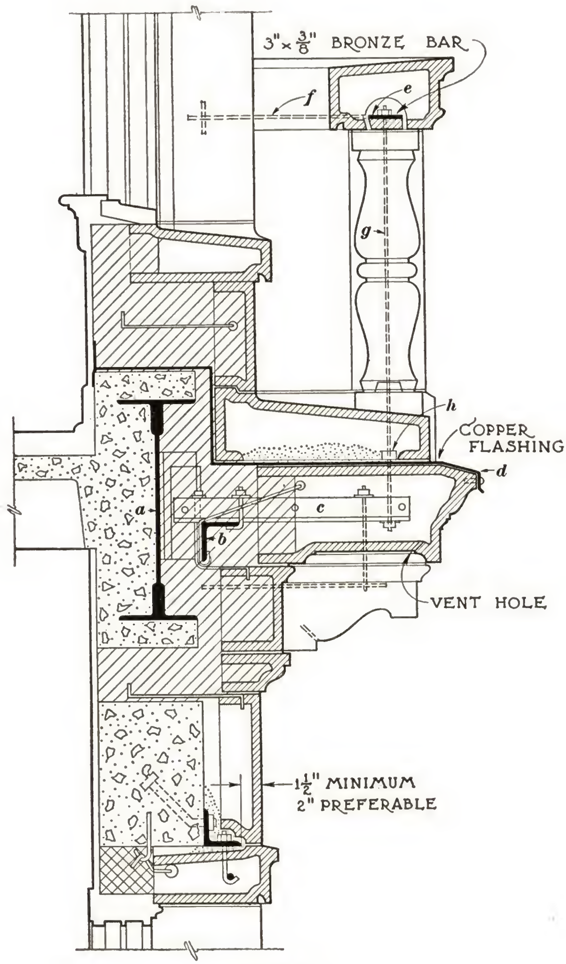


Fig. 39

Dowels are formed on the base *a* and also on the members of the baluster which fit into corresponding recessed parts as are shown at *d*, *e*, and *f*. At *g* is shown a flat bar made of bronze

that extends the entire length of the balustrade and through which the rods pass and are secured. This portion of the balustrade requires to be completed before the cap members are set in place.

101. In Fig. 39 is a section through a balustrade that is supported on a string course forming a balcony. The construction of the building is of steel and a girder is shown at *a*. Fastened to this girder is an angle iron *b* which supports the two angles *c*. These angles support the load of the string course and the balustrade above.

The construction of the balustrade is similar to that shown in Fig. 38. There are some points in which there are differences. The flashing in Fig. 39 at *d* is arranged so as to protect the string course and is secured to the front of the string course by means of brass screws and washers as already described.

A $3'' \times \frac{3}{8}''$ bar *e* runs across the top of all the balusters and is anchored to the building by the rods *f*. The vertical rods *g* are $\frac{1}{2}$ inch in diameter and extend from the bar *e* through the pedestal and some of the balusters to the angle *c*. Where these rods pierce the flashing, as at *h*, copper cups are soldered to the rods, and the cups are filled with a waterproofing compound.

102. Parapets.—In Fig. 40 is a section through a parapet wall over the main cornice of a building. This parapet wall is shown with a coping of terra cotta. The coping is constantly exposed to extreme changes in temperature. The expansion and contraction caused by these changes are liable to destroy the adhesion of the mortar in the joints and permit the penetration of water into the parapet wall and possibly into the wall below. The only successful protection against this occurrence is the thorough flashing of the wall.

In this figure a groove is made in the under sides of the coping blocks. These grooves fit on bricks *a* that are set into the wall lengthwise. This arrangement prevents the coping from moving on the wall sidewise.

A copper flashing *b* extends through the wall and the outer edge is turned down as shown at *c*. On the inside of the wall this flashing turns down over a counterflashing *d*, which covers

the entire wall and the turned-up portion of the roof flashing *e*. The entire inner surface of the wall is thereby protected. Flashing *f* is also indicated on the top member of the cornice, and is applied as already described.

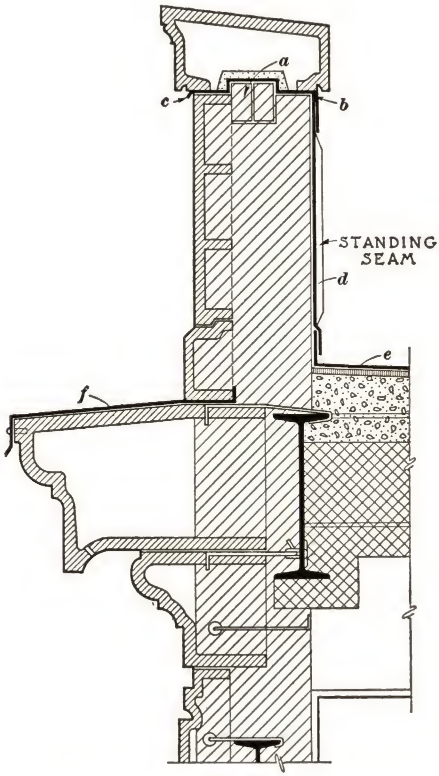


FIG. 40

103. Domes.—Architectural terra cotta has come into wide use as a facing material for the interior and exterior surfaces of domes. It is particularly adapted to this use because the material is light in weight and permits of extensive color effects, and is impervious to the weather.

The terra cotta facing is supported on a frame made of rolled-steel sections of light weight, or, more generally, on a light concrete dome which may or may not be supported on steel

shapes. Fig. 41 shows the construction of a dome made of concrete which is faced both on the outside and on the inside with terra cotta blocks. In (*a*) is a cross-section through one half of the dome and in (*b*) is a plan of part of the outside terra cotta. The reinforced concrete which forms the structural base

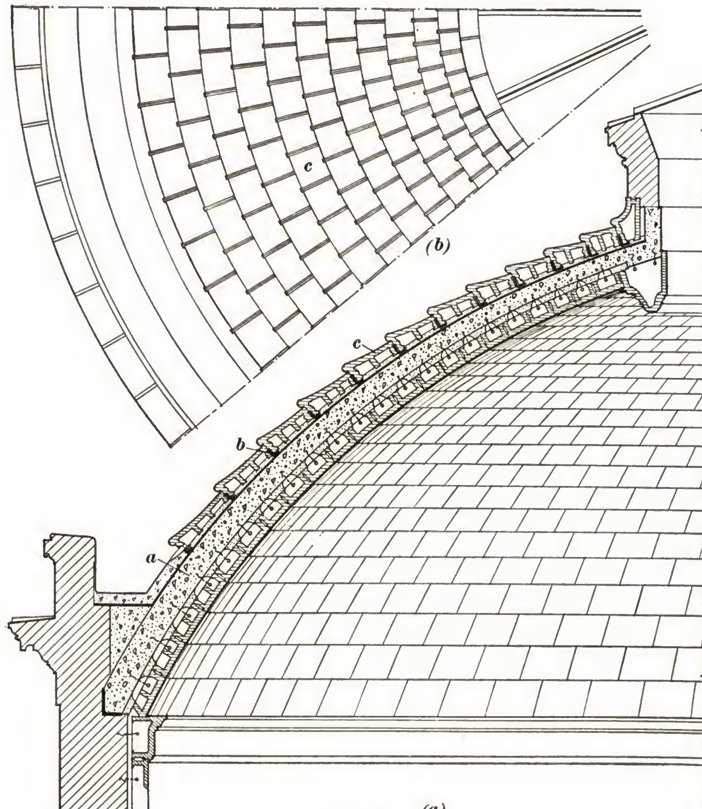


FIG. 41

on which the terra cotta rests is shown at *a* in (*a*). The steel angles to which the outside terra cotta work is attached are shown at *b*; the exterior terra cotta blocks *c* rest on the angles as well as on the concrete and are also wired to the angles.

The blocks used on the outside of the dome have lips that project over the next row of blocks below. The vertical joints

between these blocks are rectangular raised joints. A dome constructed in this manner should have a waterproof coating of

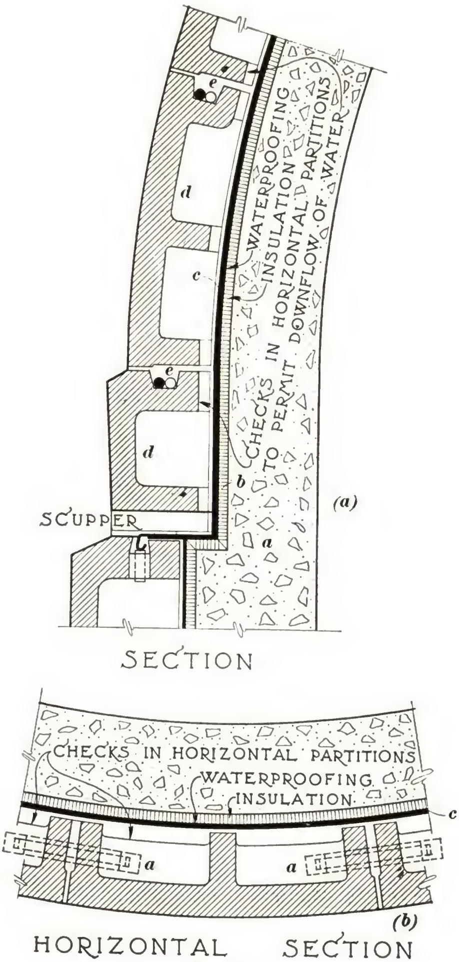


Fig. 42

felt and tar above the concrete and under the terra cotta to prevent water from working its way through the dome from any leaks that may occur in the raised joints of the outside terra cotta covering. All the outside joints should be filled with

roofer's elastic cement to insure their permanence and waterproofing value.

104. In Fig. 42 is shown a detail of a dome illustrating methods of securing the terra cotta covering to the top of the cement dome. At *a* in (*a*) is a section through a portion of the concrete dome. A layer of insulation *b* is applied to the surface of the dome over which a waterproof coating *c* is applied. The terra cotta blocks *d* are set as indicated. In the lower part of the dome there is a tendency for the blocks to be forced off the concrete surface due to the weight of the blocks above. This pressure is offset by inserting bronze rods *e* in grooves formed in the top of the blocks. These rods, being continuous around the dome, hold the block tightly against the concrete shell and prevent disruption of the terra cotta covering.

Another method may be used when the domes are small and the pressure on the lower blocks is relatively small. It is to place bronze clamps as shown in (*b*) at *a* that will be bent so that their ends will drop into holes formed in the concrete blocks. These clamps, acting with the blocks themselves, will resist moderate strains in the lower rows of terra cotta covering blocks.

Provision should be made for draining off any water that may seep through the joint between the terra cotta blocks. Checks are formed in the block as indicated in (*a*) and (*b*) and the water that may enter the dome will be stopped by the waterproofing and can find its way down the dome to a scupper, or space left in the lower block, and will flow out.

SHIPPING AND HANDLING TERRA COTTA

105. Packing.—Terra cotta is usually shipped from the factory in box cars, as they afford better protection for the blocks than open cars do.

The blocks should be carefully packed with plenty of hay or straw surrounding them. They should be laid in courses in the car and be so placed that no finished edges or faces come in contact with the car or adjoining pieces. All blocks should be so braced or wedged with the straw or hay that they cannot move about in the car.

The courses, or layers, in the car should consist of blocks having consecutive numbers, so that when the blocks are removed from the car upon its arrival at its destination they may be stacked in corresponding layers, or courses. This method will facilitate finding the blocks in their proper order when they are to be placed in the wall.

106. Receiving and Checking.—When shipping the terra cotta, the manufacturer always sends to the contractor who is to erect the material a list of the pieces included in the shipment.

When the blocks are received at the building they should be checked with the list, and if any listed pieces are missing, the factory should be notified immediately so that the pieces needed may be shipped without delay.

107. Assorting and Stacking the Blocks.—As there is danger of the terra cotta being chipped by frequent and careless handling, it should be assorted as it is received at the building and stacked in such a manner that it will not need further handling until it is required to be placed in the walls of the building. For this reason it is customary to form separate stacks of the blocks that form each part of the design, and to place the blocks that are required first at the top of the stack.

In stacking the blocks, care should be taken to prevent all edges and finished faces from coming in contact with hard substances or with one another. The best method is to pile the pieces in layers with strips of boards between the layers. If blocks are not to be used immediately, they should be stored in a shed or be covered with boards and waterproof paper to prevent their being injured. If a block is broken it will take from six to eight weeks to send to the factory and duplicate it.

108. Handling the Blocks.—In conveying the blocks from the stacks to the scaffold, the pieces should be carried singly, if possible, one block of ordinary size being a good load for one man. If it is necessary to use a wheelbarrow, the block should be placed on straw with the face up and only one block should be carried at a time, unless the blocks are very small. In that case several small blocks may be placed in the wheelbarrow, provided that straw is carefully packed around them.

SETTING THE TERRA COTTA

109. Backing Up the Blocks.—In buildings in which there are no movements in the terra cotta due to the action of wind or temperature, terra cotta may be backed up in much the same manner as cut stone or face brickwork. When the terra cotta projects beyond the face of the wall, the masonry filling of the blocks usually does not extend very much beyond the face of the wall, consequently steel anchors, such as have already been described, are used to tie the terra cotta to the masonry. These anchors if not embedded in masonry should in all cases be covered with cement grout as a protection against rust. It is dangerous to omit this protection.

Terra cotta facings for concrete walls frequently do not permit of filling the back of the blocks with masonry, but grout may be poured back of the blocks to fill the voids, if the circumstances require it.

110. Fitting.—While terra cotta blocks are usually fitted together and the edges jointed at the factory, occasions arise when it is necessary to cut the blocks at the building before they can be set in place. This may be due to errors in measurements or to irregularities in the structural parts of the building. The shells and webs of the blocks sometimes require to be cut to fit structural-steel members or to provide additional openings into which anchors may be placed. This cutting should be done only by skilled workmen and every precaution should be taken not to injure the block either on the exposed face or in the parts that are essential to its strength and anchorage. It is, however, not often necessary to fit the terra cotta at the building.

111. Anchoring.—The method of anchoring terra cotta blocks will depend upon the form of the blocks and the structure to which they are to be attached and must be adapted to meet the peculiar requirements of each case.

The most essential feature of the anchor, next to its strength, is that it shall form a rigid connection between the block and the backing to which it is fastened. The manner in which it is

made rigid will depend upon whether the anchor is of a form that can be adjusted or one that is of a fixed form.

Horizontal anchors that connect with the blocks and extend back into the masonry do not require to be adjustable. They are set into the holes of the blocks and masonry is built around the opposite ends so that when the mortar becomes hard the anchors cannot be moved.

Anchors that fit over a structural-steel member back of the block are sometimes formed by bending one end to fit into the block. The anchor is then placed in position and by means of a hammer, the opposite end is bent so that it will accurately fit over the steel. This method is possible only where the anchors are formed of small bars or straps that can be bent without endangering the terra cotta blocks.

When heavy anchors are used to fit over structural-steel members, they may be formed with turned-down ends and of such lengths that they can be easily driven into position. They may be made slightly longer than required, and when set in place may be wedged at either end by means of small pieces of broken terra cotta blocks until they are rigid, after which mortar should be slushed around the anchor connection at the block to make sure that the anchor will remain in place.

For overhanging blocks that are carried by suspension rods, an adjustable form of hanger is used. The lower end of the rod is formed with a hook through which a bar extends horizontally into adjacent blocks. The upper end of the suspension rod is provided with a screw thread and nut. The horizontal bars afford a bearing for the terra cotta and the suspension rods are brought to a rigid condition by screwing down the nuts on the upper ends. In this manner the entire weight of the block is carried by the rod.

When copper anchors are used in connection with steel, a lead washer and sleeve is placed around the anchor to keep it away from steel shelf angles so as to prevent electrolytic action between the steel and copper.

112. Bedding in Mortar.—All terra cotta blocks should be well bedded in mortar and pressed down so that each piece will

have a uniform bearing throughout the length of the block. Mortar joints for the top surfaces of all sills, projecting courses, cornices, and copings should be carefully formed so that no openings will be left through which water may enter the joints.

In setting heavy pieces of terra cotta, wooden wedges of uniform thickness are sometimes placed in the mortar bed to secure joints of uniform sizes, as the weight of the block would otherwise cause the mortar to be pushed out of the joint before the mortar becomes hard.

The mortar joints at the face of the wall frequently are finished as the blocks are laid, instead of being pointed later. When this is to be done, a rough mortar joint is formed with the trowel when the block is put in place and in the course of several hours, when the mortar has become sufficiently hard, it is smoothed with a tool to secure the form of joint desired.

When the joints in the terra cotta are to be pointed after the work has been completed, the mortar in the joints should be raked out to a depth of $\frac{1}{2}$ inch as soon as the blocks have been set. Also, loose particles of mortar on the face of the blocks should be removed so as to facilitate the cleaning of the blocks later on. The mortar that is used for repointing must not be too hard.

113. Terra Cotta Foreman.—For a large or complicated job of terra cotta, a terra cotta foreman, who is an expert in this work, is sometimes employed, at the owner's expense, to supervise the terra cotta work.

It is the duty of this foreman to see that the material arrives on the building site at the proper time and in sufficient quantities so that there will be no delay in erecting the building. He also checks off the blocks to see that they are all at hand and causes them to be piled in such order that they can be taken as wanted without unnecessary delay or lost labor.

He is responsible for the proper stacking of the blocks to keep them from injury and for seeing that they are covered up and protected with planks or boards. The supervision of the actual setting of the blocks is also part of the duties of the terra cotta foreman.

114. Protecting the Terra Cotta.—All projecting members of terra cotta courses should be temporarily protected after the blocks are laid, so that they will not be broken by falling bricks or other building material. Planks or boards are used for this purpose and it is usually specified in the carpenter's, mason's, or the terra cotta contract, that the contractor shall protect all terra cotta work until completion of the building. A board slightly wider than the projection should be laid along all projecting members and fastened securely in place by crosspieces tacked to window frames, floor joists, or wherever it is possible to make a fastening. Ornamental panels or other ornamental terra cotta work should be entirely covered to make sure that they will not be injured during the process of building.

115. Washing and Pointing the Terra Cotta.—As a general rule, terra cotta blocks are laid up without the joints being pointed, the rough mortar of the joint being raked out slightly before it becomes hard. Just before the completion of the building, the face of the terra cotta work is washed and the joints pointed. This work can be done by the masons who set the terra cotta or by another contractor who is a specialist in this line of work. The latter is the usual practice for cleaning buildings composed of brick or stone walls and terra cotta trimmings, and one contractor is then responsible for the cleaning and pointing of the face of the entire building.

Unglazed terra cotta should be washed with a weak solution of muriatic acid such as is used in cleaning brickwork, a 3-per-cent solution being sufficiently strong for this work. This may be applied with a coarse brush and the surface of the terra cotta scrubbed until all cement stains and lumps have been removed. Steel brushes, such as are used in cleaning stone and brickwork are not suited for cleaning terra cotta, however, as the steel bristles may injure the glaze of the material. Steel or iron tools, pails, etc., should never be used in connection with acid in cleaning the fronts of buildings. Glazed terra cotta never requires acid. The best cleaning material to use is an abrasive soap or washing powder. Lumps of mortar should be soaked with water and removed with a wooden stick.

The pointing materials may be ordinary cement-and-sand mortar, white-cement mortar, or colored cement mortar, as may

FIG. 43

be desired. For white enameled terra cotta, white mortar is generally used to make the joints as near the color of the terra cotta as possible. Pointing mortar may be colored any desired shade to match any color of terra cotta, but mineral colors only

Fig. 44

should be used, as coloring matter composed of vegetable colors will fade.

Joints in terra cotta are usually close, and the pointing is done with a tool about an eighth of an inch in thickness. This tool makes a joint that is slightly depressed at the center and the mortar is pushed firmly against the edges of the blocks.

Fig. 45

Glazed terra cotta has a polished surface that does not readily hold the dust and impurities of the atmosphere and therefore keeps its color for a long time. If after a time it does become soiled or blackened by deposits from the air it can be cleaned by the use of plain soap and water and will look like new work.

The results of such a cleaning are shown in Fig. 43, where the cleaned white surface contrasts decidedly with the darkened and soiled surfaces.

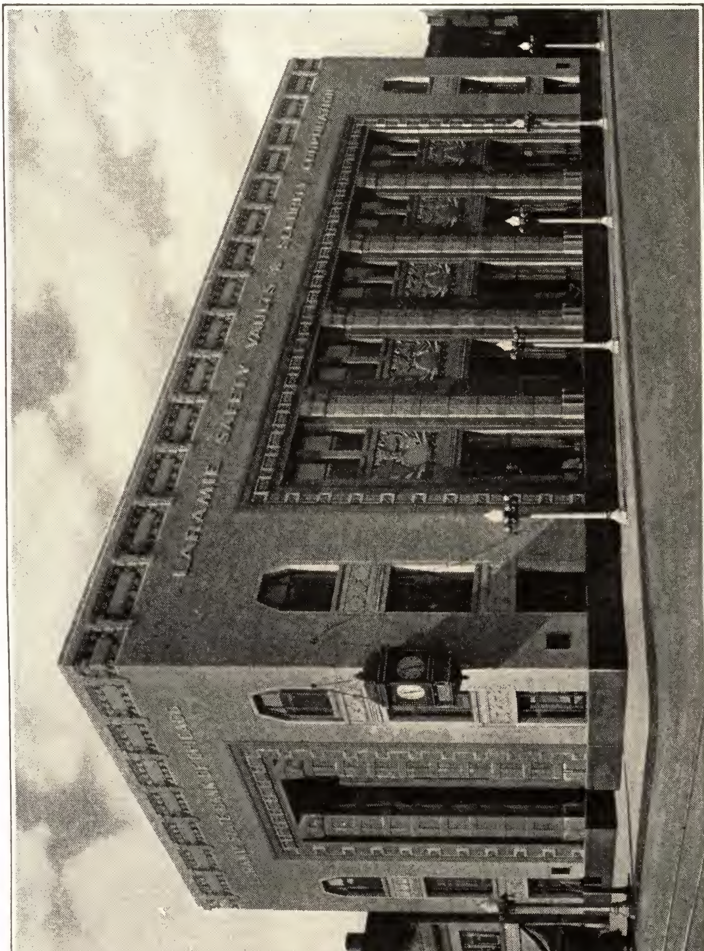


Fig. 46

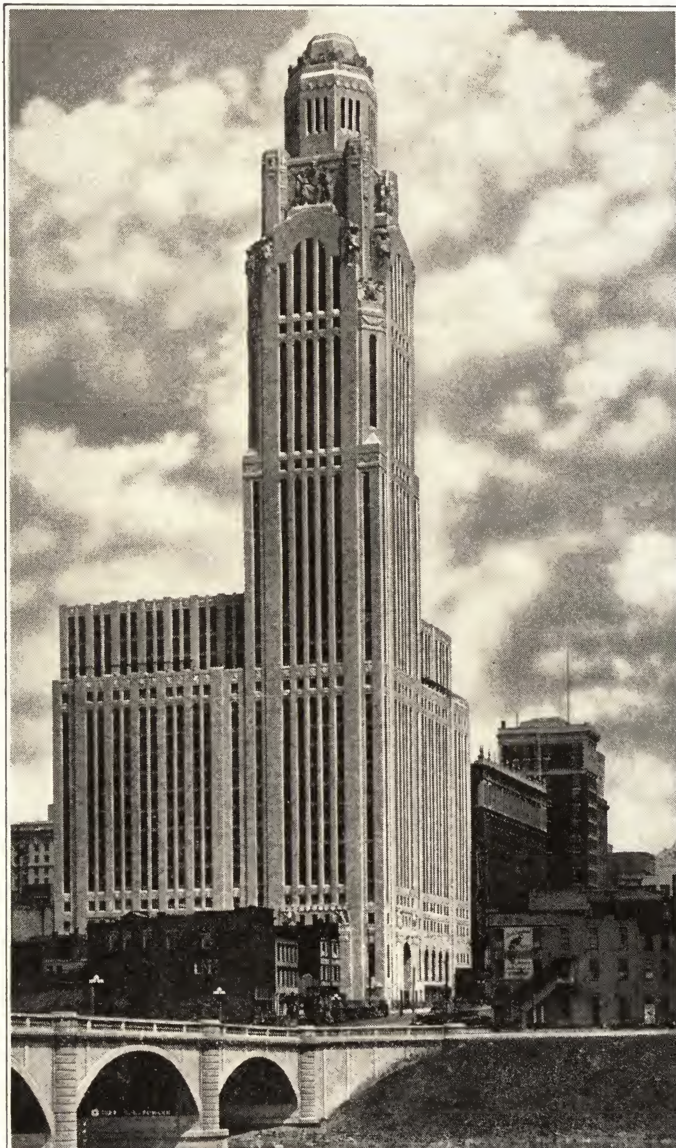


Fig. 47

Fig. 48

EXAMPLES OF TERRA COTTA WORK

116. In the following figures are shown a few examples of the application of architectural terra cotta to buildings of different kinds.

In Fig. 44 is a city store in modernistic style. The second story is faced with light-colored terra cotta with dark-colored bands. The windows are formed of structural glass blocks. This building was built in Chicago, Ill., from the designs of A. S. Alschuler, Inc.

A portion of the façade of the Chanin Building in New York City is shown in Fig. 45. The ornament shown in the fourth story is incised work with modeling in low relief.

FIG. 49

The handsome bank building illustrated in Fig. 46 is an excellent illustration of the adaptability of architectural terra cotta to the creation of a fine building.

In Fig. 47 is seen an illustration of the majestic tower of the American Insurance Union Citadel at Columbus, Ohio. The architect of this building was C. Howard Crane. In Fig. 48 is a detail of the terra cotta work on this building, showing the bold, strong texture given to the terra cotta blocks. The eagle is a fine example of bold modeling in high relief. A detail of this tower is shown in Fig. 6. In Fig. 49 is an illustration of a doorway to the West Side Y. M. C. A. Building, N. Y., designed by Dwight James Baum, Architect.